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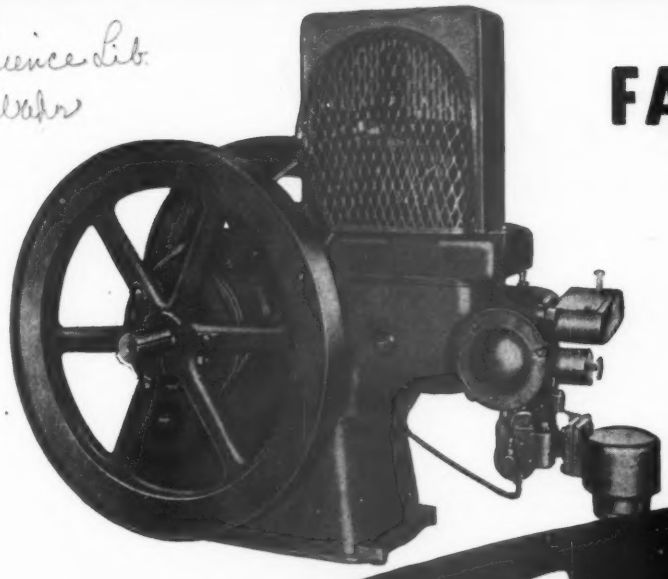

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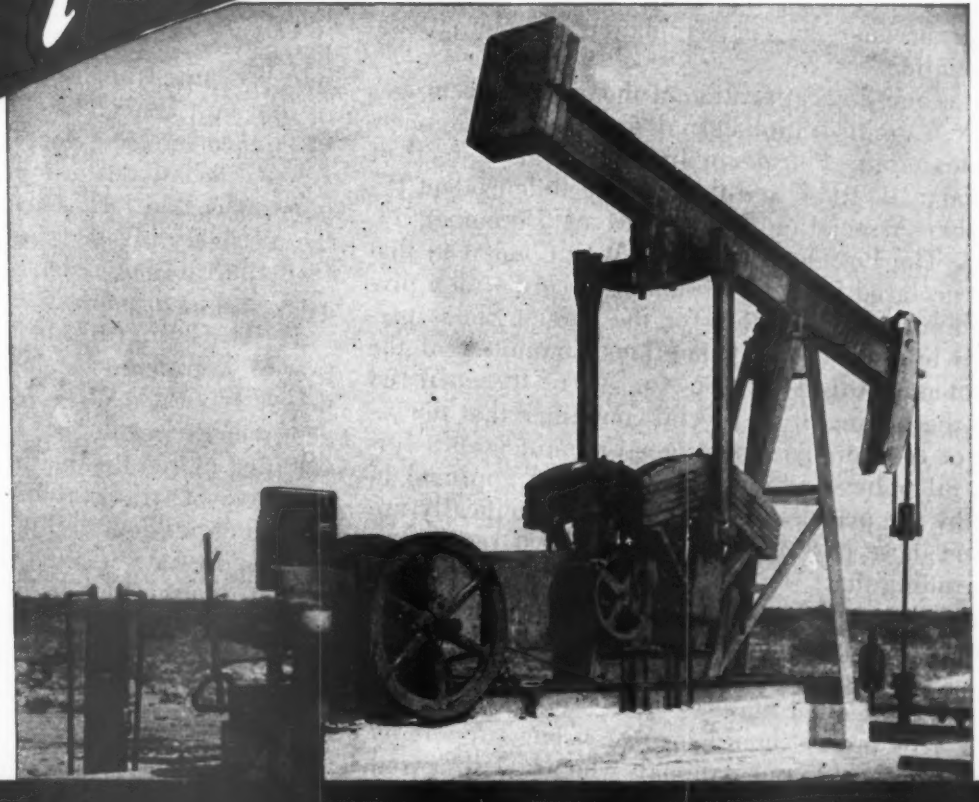

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The Course of Oil

K. C. SCLATER

OIL TREATY UNNECESSARY

Rejection and denunciation of the Anglo-American oil agreement in its present form are voiced by many groups in the industry. The fact that the agreement has been submitted to Congress for ratification as a treaty has aroused the greatest apprehension. It is contended that if passed as a treaty the agreement as now written will become the supreme law of the land and lead to governmental control of all American oil operations here and abroad.

Such a signed treaty has more far-reaching implications than its effect on the oil industry. George A. Hill, Jr., president of the Houston Oil Company, who has waged a vigorous fight against the oil agreement as now written and its ratification as a treaty, contends that "The subtle and ingenious device of an international treaty, ratified by a two-thirds vote of the Senate, can erect a species of lawful federal control of the oil business in various aspects and phases not now existent in Congress. This unassailable legal device can be similarly employed in all kinds of international treaties receiving Senate approval and ratification and affecting any matters that might become the subject matter of international negotiation."

In requesting ratification of the oil agreement as a treaty, Administration officials ignore the recommendations of the Petroleum Industry War Council of January 12, 1944, and those of the Independent Petroleum Association of America of December 11, 1943. The Petroleum Industry War Council at that time declared itself in substantial accord with a proposed foreign oil policy for the United States prepared by the Foreign Operations Committee of the Petroleum Administration for War. It concurred with the finding of its special committee that the report of the Foreign Operations Committee on a foreign oil policy for this nation merited approval in part by the petroleum industry, and specifically approved those portions of the government report recommending that:

1. The oil resources of the world can best be developed by private enterprise under a free economy.
2. A foreign oil policy should be established at once by the United States.
3. This policy should involve strong support by our government to our nationals who are willing and able to play an important role in the development of the oil resources of the world.
4. The government should not participate either directly or indirectly in the ownership or operation of foreign properties.

International economic cooperation in the postwar period must be based on economic considerations only and be divorced from politics. An international forum should be provided for the oil men of each nation freely to discuss and resolve their common problems as they arise. Such a group should be free from political or diplomatic pressure of any kind.

In the field of international relations all the oil industry asks is the diplomatic support of its government in seeing that the interests of American oil companies and American nationals operating in foreign fields are protected in conformance with international law.

OIL-FINDING TECHNIQUE

It may come as a surprise to many to know that the "doodlebug" is credited with the discovery of the West Edmond field, Oklahoma, a stratigraphic trap type structure. The man responsible for the discovery of the field, A. Gutowsky of Oklahoma City, unable to enlist the interest of local oil companies and individuals in the area because he lacked geological or geophysical data to support his "hunch" on the oil possibilities, sought, and ultimately obtained, financial backing outside the state. His hunch stemmed from the prognostications of doodlebug operators. This combination of blind faith and dogged persistence on the part of Gutowsky in pursuing his hunch resulted in the drilling of the discovery well of the West Edmond field, one of the major finds in Oklahoma in recent years. So, despite our highly developed techniques, a hunch, combined with dogged persistence and luck, once more has played a part in the discovery of oil. It is likely to continue to do so from time to time. Each discovery of this kind should act as a spur to improve existing oil-finding methods.

Ira H. Cram, president of the American Association of Petroleum Geologists, in an address before the New York Academy of Science early this month, gently chided geologists for the lack of effort in developing more effective field methods leading to the discovery of stratigraphic traps, and the tendency to depend on random drilling. Imaginative geology and much more daring than geologists in general have heretofore practiced, he pointed out, are necessary to find the new oil that we will need, and they must be applied to the task even in the use of the most expensive geophysical tools and the interpretation of geophysical data.

Geologists have become painfully aware of the fact that more intensive geological study and interpretation is required for the discovery of stratigraphic traps, a type of reservoir that is now generally believed to be one of the greatest potential future sources of oil. Their discovery is a challenge to the abilities and efforts of the oil geologists, who, above all, must exercise the same persistence in their quest as the man with a hunch.

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National Petroleum Situation

DRILLING QUOTA TO BE REALIZED. Total drilling operations for the first nine months of this year were about 10 per cent below the PAW quota, but current and prospective completions of over 2000 wells per month are expected to bring the year's total to 24,000. With increased materials promised by the War Production Board, a program of 27,000 well completions projected for next year may reasonably be expected to materialize.

WILDCATTING BEHIND SCHEDULE. The necessity for replacement of reserves which have been heavily drawn upon for war needs dictated a wildcatting program of at least 5000 wells in 1944. Results for the first nine months, however, show that the industry has only drilled 75 per cent of its quota. Only 2821 wildcats were drilled to date, against a cumulative quota of 3750 wildcats. It is evident now that only 4000 wildcats will have been drilled this year and these will only add about 465 productive oil wells, many of which will prove of minor importance in the way of new reserve discoveries.

IMPROVED STOCK POSITION. Stocks of all refined products are 22 million barrels greater than a year ago. Whereas this is an increase of 10 per cent, increased requirements for war have reduced the increment to only 4 per cent in terms of current demand. Fuel oil stocks represent a gain of 5 days supply over a year ago. Distillate supplies have improved materially over last year because of the fact that military storage facilities are reported filled to capacity and for the time being permit diversion of current output to civilian channels.

GASOLINE STOCKS GREATER. Stocks of motor fuel are 5,600,000 barrels greater than a year ago, but in terms of current demand represent only 33 days supply, against 34 days supply a year ago. Thus, while volume is up 9 per cent the supply is actually 3 per cent smaller than it was at this time last year. Figures for the first nine months show that the production of motor fuel equaled demand, whereas in the same period of 1943 demand exceeded production by 42,000 barrels daily.

SHRINKING CRUDE STOCKS. The crude oil stock situation continues to grow worse. At the close of September the stored supply of crude only represented a 45 days supply, against 55 days supply a year ago. On the basis of current requirements, present crude stocks are 18 per cent smaller than a year ago, although the actual volume in storage is shown to be but 8 per cent smaller. In measuring the economic stock position of the industry against actual stocks of crude and refined products on hand, it is apparent that crude oil stocks are about 70,000,000 barrels below the economic level necessary to meet current and prospective war and civilian requirements. Such a stock build-up, however, would call for an increase over current crude output of 190,000 barrels a day. ★★★

Comparative Statistics, September, 1944

*All figures are computed on a Bureau of Mines basis.**

	Sept. 1944(p)	August 1944(p)	Sept. 1943	This year to date	Last year to date	Per cent change
Wells drilling	4,215	4,210	2,721	4,215	2,721	+ 55
Total wells drilled	2,060	2,086	1,826	16,062	12,809	+ 25
Development wells	1,742	1,713	1,557	13,241	10,358	+ 28
Oil	1,193	1,161	920	9,173	6,635	+ 38
Gas	205	186	188	1,561	1,271	+ 23
Dry	344	366	449	2,507	2,452	+ 2
Per cent dry	19.7	21.4	28.8	18.9	23.7	— 4.8
Wildcat wells	318	373	269	2,821	2,451	+ 15
Oil	44	40	38	344	320	+ 8
Gas	13	9	6	91	44	+107
Dry	261	324	225	2,386	2,087	+ 14
Per cent dry	82.1	86.9	83.6	84.6	85.1	— 0.5
Crude production	142,160	¶145,115	130,407	1,242,119	1,097,875	+ 13
Daily average	4,739	¶4,681	4,347	4,533	4,022	
Crude stocks	226,412	230,015	245,192	226,412	245,192	— 8
Days supply	45	46	55	45	55	
Crude demand†	149,553	153,590	133,868	1,292,141	1,069,297	+ 21
Daily average	4,985	4,955	4,462	4,716	3,917	
Natural gasoline production	8,590	¶8,706	7,702	74,730	66,660	+ 12
Daily average	286	¶281	257	273	244	
Motor fuel production	61,920	63,090	54,847	543,605	440,828	+ 23
Daily average	2,064	2,035	1,828	1,984	1,615	
Gasoline yield, per cent	39.0	38.4	38.1	38.6	36.7	+ 1.9
Motor fuel stocks	69,500	¶71,375	63,909	69,500	63,909	+ 9
Days supply	33	35	34	33	34	
Motor fuel demand	63,795	64,015	56,495	542,417	452,323	+ 20
Daily average	2,127	2,065	1,883	1,980	1,657	
Fuel oil stocks	102,980	94,620	97,658	102,980	97,658	+ 5
Days supply	59	52	54	59	54	
Fuel oil demand	52,177	56,835	53,777	534,987	487,966	+ 10
Daily average	1,739	1,833	1,793	1,952	1,787	
Refinery still runs	139,750	145,245	126,088	1,238,289	1,042,173	+ 19
Daily average	4,658	4,685	4,203	4,519	3,817	
All refined stocks	253,470	250,300	231,454	253,470	231,454	+ 10
Days supply	54	53	52	54	52	

*Unless otherwise stated, all figures represent thousands of barrels. (p)—Preliminary.
‡Includes benzol. †Domestic and foreign. ¶Revised estimate. §No change since prices frozen. Prices do not include subsidies.

Economic Position of Petroleum Industry

First nine months, 1944.

	Normal	Actual	Per cent of normal
Drilling (wells completed)	17,900	16,062	89.7
Production (daily average)	4,760	4,533	95.2
Refining (daily still runs)	4,602	4,519	98.2
Stocks (crude and refined)	579,000	479,882	82.9
Price of crude oil, per bbl	$1.96	$1.22	62.2

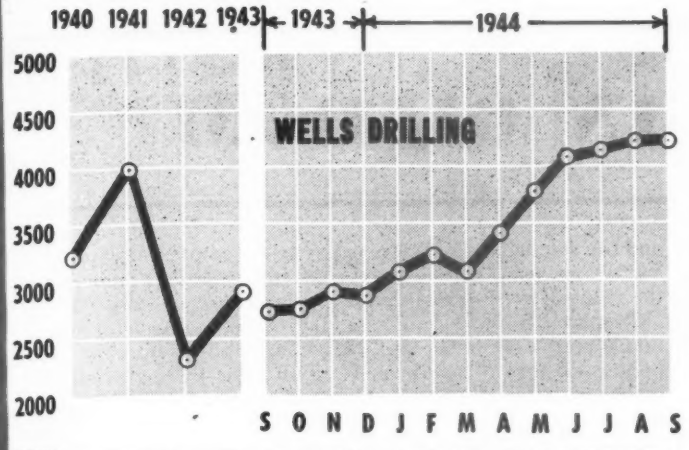
Crude Prices by States for September, 1944§

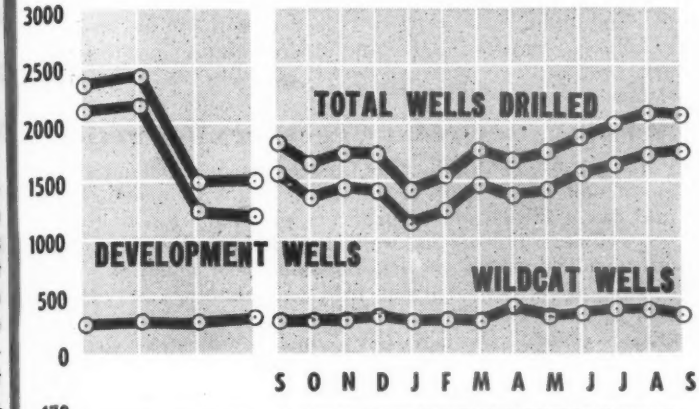
U. S. average	$1.22	Louisiana	$1.20
Texas	1.23	Arkansas	1.25
California	1.07	New Mexico	1.04
Oklahoma	1.17	Mississippi	1.10
Kansas	1.17	Illinois	1.37
		Other States	1.89

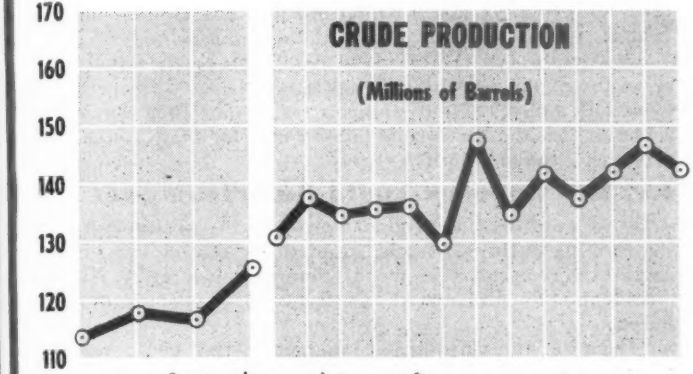
Basic crude prices	
Oklahoma-Kansas (36 gr.)	$1.17
Texas Gulf Coast (36 gr.)	1.40
East Texas	1.25
West Texas (36 gr.)	1.04
Calif., Signal Hill (26 gr.)	1.11
Pennsylvania Bradford	3.00

Drilling and Production Statistics by States

	Sept. 1944(p)	August 1944(p)	Sept. 1943	This year to date	Last year to date	Per cent change
Total wells drilled	2,060	2,086	1,826	16,062	12,809	+ 25
Texas	516	565	497	4,121	3,068	+ 34
California	167	168	127	1,452	988	+ 47
Oklahoma	200	155	147	1,251	904	+ 38
Kansas	152	171	181	1,347	1,229	+ 10
Louisiana	77	71	55	568	495	+ 15
Arkansas	11	41	21	218	184	+ 18
New Mexico	27	29	20	290	162	+ 79
Mississippi	17	4	6	98	61	+ 61
Illinois	175	171	147	1,304	1,272	+ 3
Other states	718	711	625	5,413	4,446	+ 22
Wildcats drilled	318	373	269	2,821	2,451	+ 15
Texas	120	136	83	1,020	819	+ 25
California	7	12	18	150	152	— 1
Oklahoma	45	32	26	274	229	+ 20
Kansas	37	46	40	372	348	+ 7
Louisiana	10	6	8	95	92	+ 3
Arkansas	1	12	4	47	53	— 11
New Mexico	5	6	4	50	40	+ 25
Mississippi	8	5	5	64	25	+156
Illinois	20	44	30	262	324	— 19
Other States	65	74	51	487	369	+ 32
Daily crude production	4,739	¶4,681	4,347	4,533	4,022	+ 13
Texas	2,174	2,130	1,844	2,012	1,527	+ 32
California	877	862	781	841	773	+ 9
Oklahoma	335	341	334	334	337	— 1
Kansas	268	277	282	270	297	— 9
Louisiana	355	359	349	353	333	+ 6
Arkansas	80	82	76	80	73	+ 10
New Mexico	105	106	111	109	103	+ 6
Mississippi	47	45	49	43	55	— 22
Illinois	202	206	220	211	227	— 7
Other States	295	¶273	301	280	297	— 6







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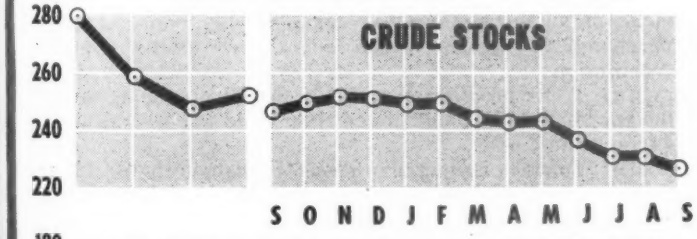
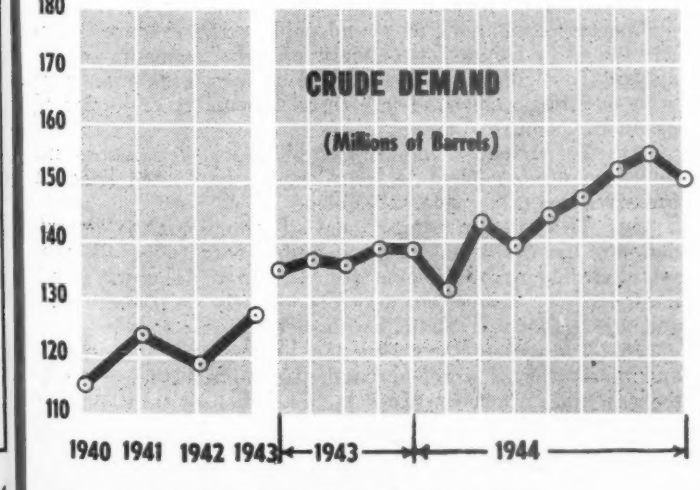
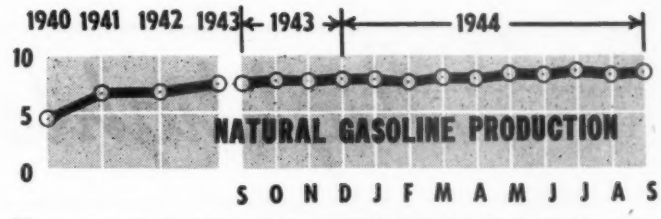
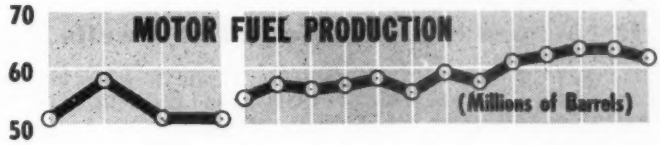
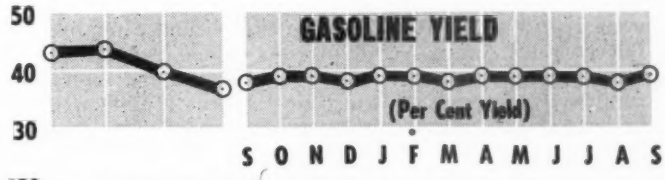
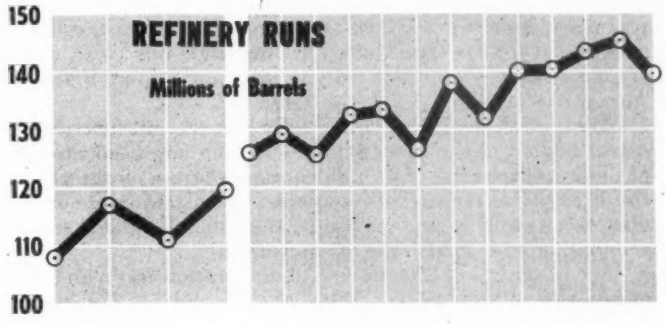


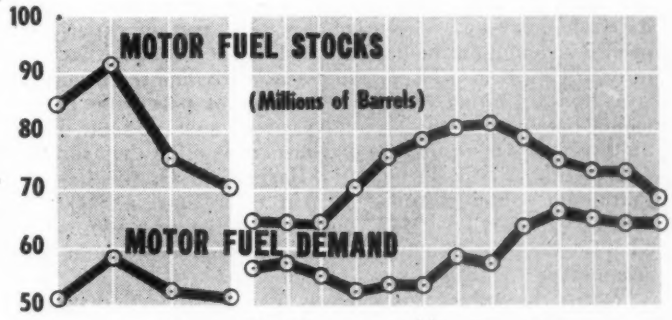




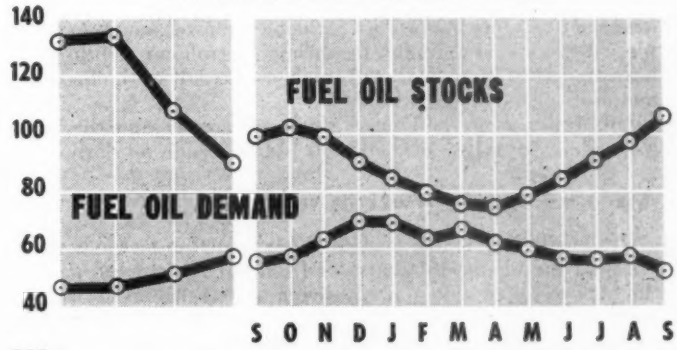


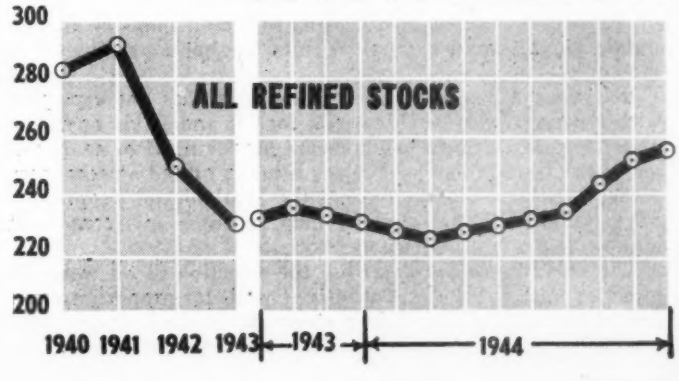






Years 1940-43 are monthly averages.





Highlights IN OILDOM

Recommends drilling of 27,000 wells

Petroleum Administrator for War Harold L. Ickes has recommended that a minimum of 27,000 oil and gas wells be drilled in 1945, of which 5000 should be exploratory wells.

The 1945 program calls for 3000 more wells than were scheduled for 1944, and although it would be desirable to drill an even greater number to meet the extraordinary requirements for crude oil, Administrator Ickes explained, it is thought this would be impossible in the face of the continuing shortages of manpower, materials, and facilities. At least 27,000 wells will be necessary to ease the strain upon the productive capacities of the nation's oil fields, which currently are producing an all-time high of more than 5,000,000 bbl. of crude oil and other petroleum liquids every day, the petroleum administrator said, of which more than 4,700,000 bbl. are crude oil.

Commenting on the 1945 drilling program, Deputy Petroleum Administrator Ralph K. Davies said:

"The petroleum industry has fully met the military requirements for petroleum and its products. The unprecedented size of these demands has placed an enormous strain on the productive capacity of the nation's oil fields. To sustain crude oil production at or near present levels, the rate of finding and developing new oil fields must be increased.

"Accordingly, the Petroleum Administration for War recommends that the petroleum industry drill at least 27,000 wells during 1945 and urges that at least 5000 of these be exploratory wells. Although the industry, at PAW's request, has expanded its exploratory activity during this year, further expansion is needed to maintain the high production rates that are necessary to supply the armed forces and essential civilian requirements."

At the beginning of 1944, estimates of petroleum requirements based upon military advice indicated that the United States would be required to produce crude oil at the average of 4,400,000 bbl. daily during 1944, Davies said. On this basis, the Petroleum Administration for War established a 24,000-well drilling program for 1944. Allotments of materials were obtained from the War Production Board to enable the industry to accomplish this program.

"While the industry was nearly 5 per cent behind schedule on its drilling program during the first half of this year, it is expected that the more than 450 additional rotary rigs which have been put into operation will bring the program up to schedule," Davies said. "In the meantime, petroleum requirements have soared to unprecedented levels as a result of the increased tempo of military activities."

Oil producers in the United States are now being called upon to produce in excess of 4,700,000 bbl. of crude oil daily.

Air and gas injection methods

Practical and expedient air and gas injection methods for increasing the oil production rates from partly depleted pools of the Appalachian fields are proving successful as a wartime measure to help ease the burden on the nation's major flush petroleum fields, Dr. R. R. Sayers, director of the U. S. Bureau of Mines, has revealed in releasing to the oil industry and the public an informative report written by bureau engineers in that area.

Because the discovery rate of new fields has not kept pace with the unprecedented demands for oil and fields operating under primary recovery methods are producing at or near their maximum rates, greater emphasis is being placed on secondary recovery methods for increasing the available oil supply, Dr. Sayers said. The Appalachian fields produce oils containing high percentages of lubricants.

The bureau's report describes the selection of oil wells for injection-well use, the preparation of wells for proper introduction of the gas into the oil formations, the methods of determining the volume of gas that should be injected daily in each well, and the volume and pressure capacity of compressor equipment. Various means of measuring the gas injected and produced, and the value of records thus made available, are also discussed.

Prepared by Sam S. Taylor, petroleum engineer in the bureau's petroleum field office, Franklin, Pennsylvania, the report points out that it is intended mainly "for those thousands of operators in the Appalachian region owning a few wells producing small quantities of oil daily. Many such operators are anxious to increase their production rates by stimulative means and to rehabilitate their wells so that they will produce more oil to help win the war but, in general, are unfamiliar with secondary-recovery operations and cannot afford to hire technical assistance."

Arkansas secondary recovery operation

The Arkansas Oil and Gas Commission has announced that an attempt will be made to rejuvenate by the reinjection of natural gas, a 22-year-old oil pool now producing less than 3 bbl. per well per day from 202 wells, according to Alec M. Crowell, director. The pool is the Blossom sand pool found at a depth of 2150 ft. in the Stephens field of Columbia, Nevada, and Ouachita counties. The permit for the secondary recovery operations went to the Ohio Oil Company, who owns and operates 125 wells in the Blossom pool. The experiment will be supervised for the state by Dr. George H. Fancher, secondary recovery expert retained by the oil and gas commission, and John F. Gallie, senior geologist of the commission.

All operators in the Stephens field have been invited to observe the experiment and if they are satisfied with the results from both a physical and economic standpoint, then they will be asked to consider the formation of a unit for the purpose of repressuring the field in its entirety.

I.P.A.A. opposes Anglo-American pact

Directors of the Independent Petroleum Association of America, meeting in Dallas, Texas, adopted a resolution opposing the Anglo-American oil agreement. Offered by George A. Hill, Jr., president of the Houston Oil Company of Texas, the resolution stated:

"The treaty-making device inherent in the Anglo-American petroleum agreement is being wrongfully used to vest the congress or the executive department of the United States government, or an international oil commission, powers in time of peace not now vested in the federal government under our constitution:

"(a) To fix production quotas in the oil producing areas of the world, including the United States and the several oil producing states; and

"(b) To make market allocations throughout the world; and

"(c) To fix prices of oil and its products, or price ceilings, or what may be deemed 'fair prices'; and

"(d) To take jurisdiction over conservation regulations by making determinations of 'sound engineering practices' to be effectuated by federal law or international agreement; and

"(e) To regulate our domestic oil business in relation to the economic advancement of foreign oil consuming or foreign oil producing countries; and

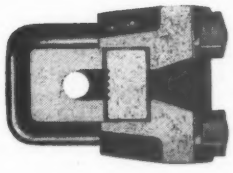
"(f) To surrender the control of import regulations and duties on foreign oil importations while the United Kingdom preserves 'imperial preferences'; and

"(g) To vest in an international oil commission the determination of 'peaceable' and 'non-peaceable' countries as the basis for eligibility or banishment from international trade in oil irrespective of whether our nation is otherwise on friendly terms and enjoys amicable relations with such nations; and

"(h) To regulate 'the production, processing, transportation and distribution of petroleum' in the United States (except as to the now recognized constitutional regulation of transportation in interstate and foreign commerce); and

"(i) To legalize cartels."

Alike in Quality



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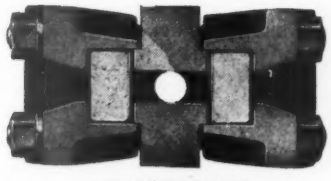

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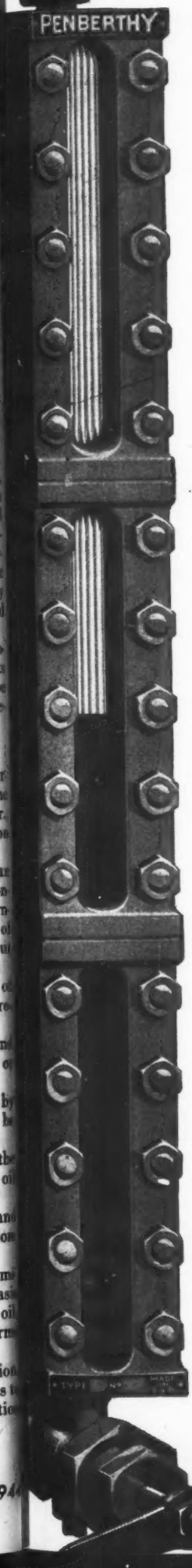

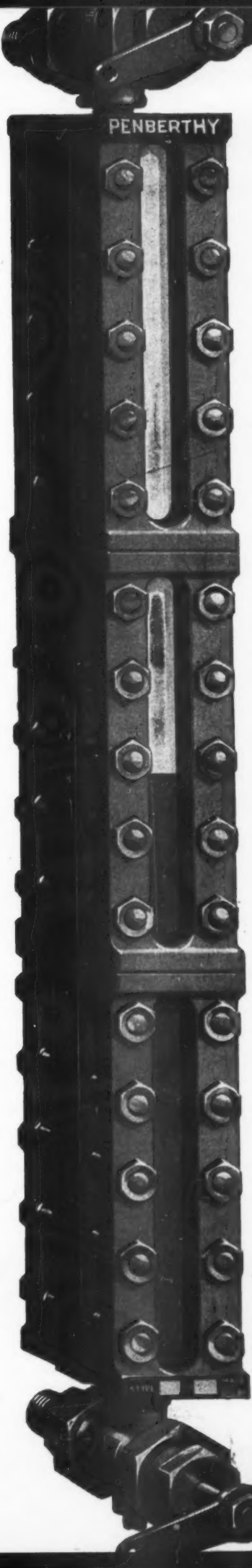

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PENBERTHY PRODUCTS

MAJOR *Oil Field* ACTIVITIES

▼ **CUBA.** Success of one of the operating companies that drilled three producing wells in the Jarahueca field in Las Villas Province, Cuba, has focused the interest of oil men on this area. Oil brought in is of light gravity, somewhat similar to gas oil, and can be used as a motor fuel in its natural state. Little drilling activity is going on in the Motembo field where there has been a steady decline of production.

▼ **CALIFORNIA.** Shell Oil Company has opened a new pool in the Los Angeles Basin with the completion of Bryant No. 5 at Seal Beach. The well, completed at 7848 ft., is producing 1602 bbl. of 31-gravity oil from the McGrath sand zone. It is located 650 ft. south and 959 ft. east from the north one-quarter corner of 11-5-12, north of the Seal Beach fault. The first producer on the north side of the fault, it is also Shell's first producer in the Seal Beach field.

▼ **KANSAS.** Sunray Oil Corporation tested the No. 1 Younger, as a pool opener in the NE SE NE of 6-14-17w, 2½ miles west of the Catherine pool in Ellis County, northwest Kansas. The well was treated at 3525-74 ft. in the Arbuckle with 250 gal. of solution. Before acid was applied, the well swabbed 2 bbl. of oil an hr. After swabbing it made 75 bbl. an hr.

Dickey Oil Company has given Barber County another gas pool with the opening of No. 1 Hargis, in the CEL SE SW of 3-31-14w, 2½ miles northwest of the Lake City oil pool. Drilled to 4681 ft. in the dry Arbuckle, operators then plugged back to 4431 ft. opposite the Maquoketa. The well gauged 4,000,000 cu. ft. of gas daily from 4415-31 ft.

▼ **MICHIGAN.** Shell Oil Company Koth No. 1 SW NE NW section 2-16n-4e, Bay County, pool opener, flowed 145 bbl. of oil on a 3-hr. test after perforating casing in Dundee limestone. It is Shell's first oil discovery in the state, and was the seventh major wildcat strike for Michigan this year. Extra significance was attached to the discovery because the test was located by seismograph surveys. Shell has the entire Bay block in Fraser township.

▼ **OKLAHOMA.** Sinclair Prairie Oil Company has opened a new high gravity pool in Lincoln County with No. 1 Danker NE 28-14-3. Production is from the Jones Cleveland sand and total depth is 3498 ft. It is producing 5 bbl. of 51-gravity oil per hr.

▼ **KENTUCKY.** The Shell Oil Company No. 1 Hamilton, in 14-0-27, a wildcat discovery well in Davies County, has been completed for 37 bbl. of oil a day. Production is from the Cypress sand at 1833-45 ft. The test was originally drilled to 2358 ft. and plugged back.

▼ **ILLINOIS.** Phillips Petroleum Company No. 1 Richland, 6 miles southwest of Olney, Richland County, in the NE SE SE No. 6-2n-10e, produced 628 bbl. of oil per day with no acid. Production is from the upper McClosky limestone from 3150-59 ft.

▼ **WYOMING.** Barnsdall Oil Company and Husky Refining Company opened a new pool on the Half Moon structure, Park County, Wyoming, with No. 1 Morrison in NE SW NW of 23-15n-102w, swabbing 840 bbl. a day of 17-gravity oil. The pay is from the Basal Embar formation. Barnsdall and Husky Refining Company own jointly approximately 3000 acres on this structure.

▼ **LOUISIANA.** The Texas Company has opened a gas pool for Red River Parish with No. 1 Sempt Russ, wildcat in the northwestern part of the southeast quarter of section 16-12-10w. Gas was shown on a drillstem test in the Rodessa zone between 5011-33 ft. The well is located about a mile and a half from the shallow production area of Bull Bayou.

Barnsdall Oil Company opened oil production in the West Tepetate area of Jeff Davis Parish in its No. 1 P. and D. M. Miller. The well is located in section 38-7s-3w. Total depth is 10,032 ft.

In Acadia Parish Phillips Petroleum Company opened a new gas pool with completion of its No. 1 Onez, section 15-10s-1e. The hole is bottomed at 10,020 ft., but is showing gas at 7738-41 ft.

The California Company, a subsidiary of Standard Oil Company of California, has extended the Tuscaloosa sand production from Mississippi into southern Louisiana with the opening of No. 1 Pasternock. The well is in section 27-9n-10e, in the Lake St. John area. The discovery was reported to have flowed 250 bbl. of 60-gravity condensate in 24 hr. The well was drilled to 9210 ft.

▼ **MISSISSIPPI.** A new oil field for Mississippi was promised with the opening of Gulf Refining's No. 1 C. V. Cooper, Baxterville area, Lamar County, 6 miles northeast of the Louisiana corner. Formations logged were the Moody Branch at 2261 ft., Midway at 5648 ft., Clayton, 6432 ft., Selma, 6450 ft., and top of the Eutaw at 7423 ft. On drillstem test at 7832 ft., tool open 30 minutes, the recovery was 600 ft. of free oil, 90 ft. of oil-cut mud, and 600 ft. of water cushion.

▼ **NEW MEXICO.** The first commercial oil production in New Mexico from below the upper Permian horizon has been discovered by Humble Oil and Refining Company in No. 1 Federal-Leonard in southwest Lea County. It has tested for 480 bbl. of 47.4-gravity sweet oil and 10,000,000 cu. ft. of gas from a 21-ft. section at 11,870-891 ft. in the Ellenburger. The well is 8 miles north of the nearest Ellenburger lower Ordovician oil production in north Winkler County, Texas.

▼ **TEXAS.** Panhandle Refining has opened a new Caddo pool for Throckmorton County with No. 1 W. B. Ewalt, block 2170 TE&L survey. Situated 6 miles east of Throckmorton, the discovery well flowed 200 bbl. of oil in 2½ hr. on initial test.

D. D. Feldman opened a new field in Clay County with No. 1 H. D. Stine, a wildcat that flowed 40 bbl. of oil hourly over a period of 8 hr. from the Caddo lime at 5610-28 ft. The discovery is in lot 25, block 4, Houston and Texas Central Railroad survey, 3 miles southeast of Ralston.

Humble Oil and Refining Company's No. 2 Donald and F. B. Duncan, David Wade survey, in the Hungerford area of Wharton County, gives promise of opening a new pool. Total depth is 7304 ft.

Eltex, Ltd., opened a new pool for Harris County recently with the No. 1 Bender Estate, Marcy C. Bulrice survey. Total depth is 6249 ft. with production from 6244-47 ft. The discovery well, making between 350 to 400 bbl. of oil daily, is located ¾ mile southeast of the town of Spring in an area where there has been extensive leasing for some time.

New Russian deposits

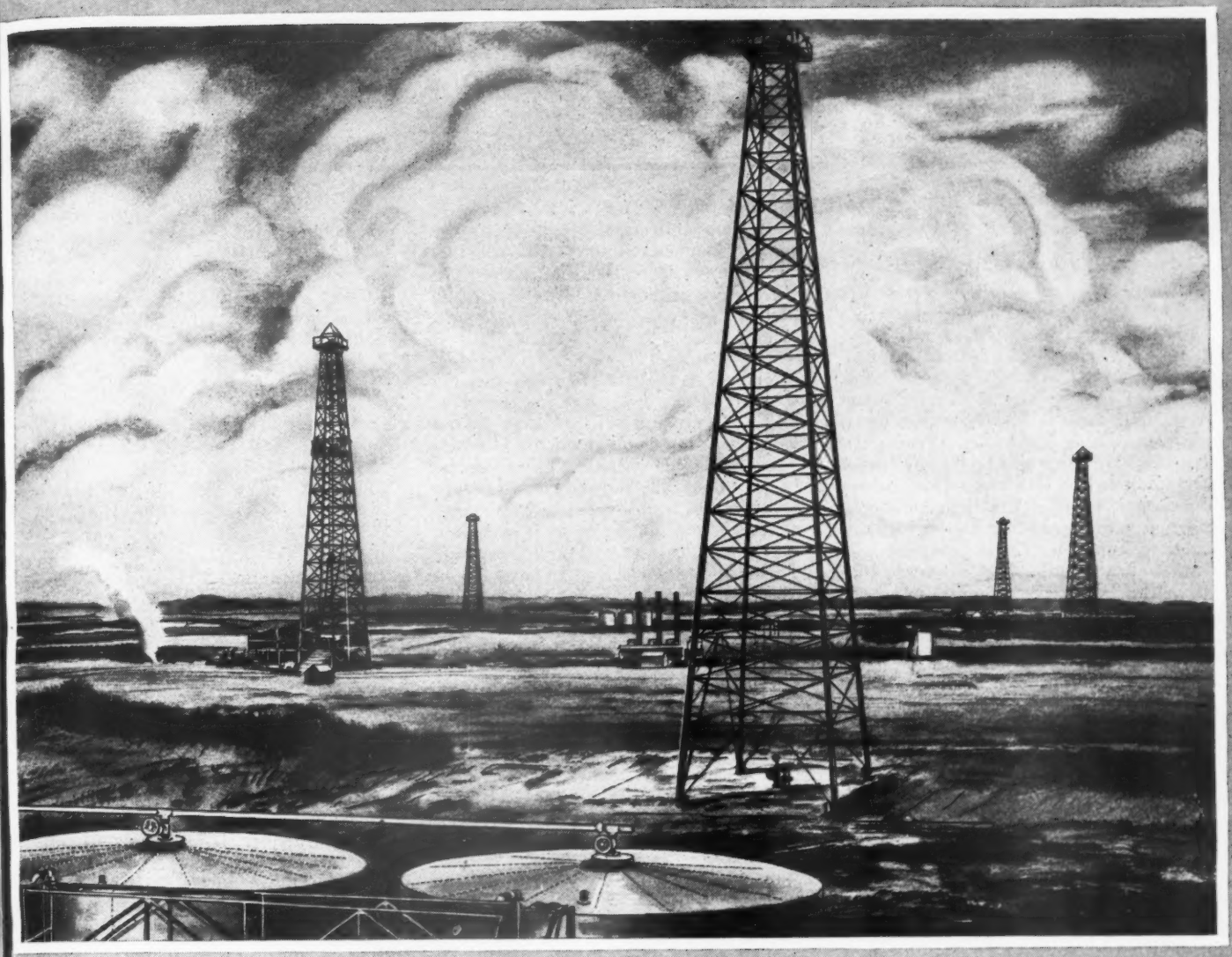
New petroleum deposits have been discovered in the Zhigulev mountains in the bed of the Volga River, Kuibyshev area, Russia. Some of the deposits are said to be those of the Caucasus. These and similar discoveries indicate that the productivity of the "Second Baku" is increasing still further.

In the Baku region 24 deposits are being developed, and there is a growing belief that large deposits may lie on the bottom of the sea around the Apsheron Peninsula. To develop production from this source engineers are faced with the problem of drilling wells far offshore and constructing superstructures for wells above the surface of the sea that will withstand heavy weather.

Alabama discoveries

H. L. Hunt, independent Dallas oil operator, has opened his third oil pool in Alabama and given the state its second pay zone with his No. 1 W. S. Scruggs, section 32-11n-4w Choctaw County. The well was completed in the Eutaw section to produce 50 bbl. of oil per day from 3460 ft. to 3501 ft. The new well is about equidistant between the Gilbert pool, Albama's first, and the operator's recently discovered No. 2 Land.

The second oil pool opened by H. L. Hunt for Alabama, No. 2 Land, is in the western part of Choctaw County, approximately 5 miles west and a little north of his first discovery in the state. The discovery well has been completed for 50 bbl. of oil in 24 hr. from 2832-38 ft. in the Selma chalk.



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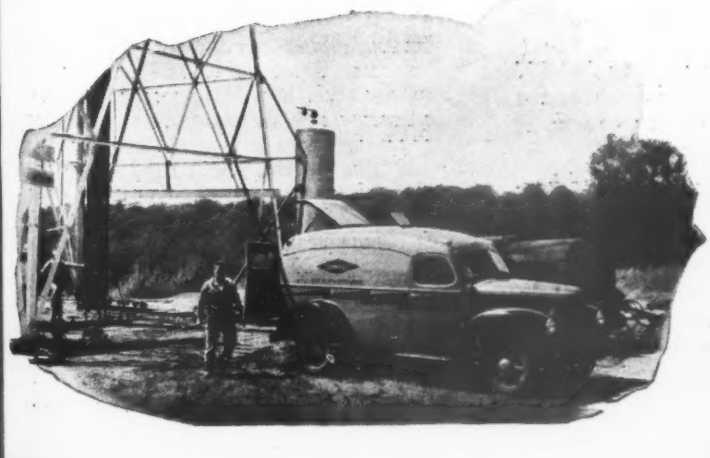

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MAJOR *Pipe Line* ACTIVITIES

▼ **NEW LINES FOR CALIFORNIA.** PAW has authorized 3 new pipe line projects for California. The new lines will provide an outlet for increased crude production in the United States Elk Basin naval reserve for movement to Los Angeles refineries. General Petroleum Corporation of California will construct 15,000 ft. of 6-in. line from Standard Oil Company of California's Buena Vista tank farm in Elk Basin to connect with its existing line to Los Angeles. An 8-in. 45,000-ft. line will be laid by Union Oil Company of California from Buena Vista tank farm at Elk Hills to a connection with an existing line at Midway Station, Taft. The Texas Company will construct a 61-mile, 10½-in. crude line from Elk Hills, Kern County, to a connection with the Idle Valley pipe line in Kings County.

The work, began the latter part of September, is to be completed in November. Total cost is estimated at $287,225, and the project will, when completed, increase capacity of the system by 5000 bbl. per day. The new Union Oil Company extension, beginning this month and being completed in November, will provide a through pipe line route for movement of 25,000 bbl. daily of Elk Hills crude to tidewater for loading in tankers destined for Los Angeles refiners. November 1 will mark beginning of construction by The Texas Company with completion expected January 1. The Texas line will have an initial capacity of 20,000 bbl. per day.

▼ **LINES EVEN FOLLOW PATTON.** Working under an organization known as the Petroleum Distribution Group, oil men from Texas, Oklahoma, Louisiana, and California, have successfully managed one of the greatest petroleum distributing systems the world has ever known by keeping the army supplied with high-grade aviation fuel and diesel oil from Cherbourg to the battlefront as it advanced across France. The supply lines are referred to as "the pipe line." In reality there are many pipe lines, 4 to 6 inches in diameter. Pumping units in service by the hundreds compare in size to an office desk.

When the beachheads in Normandy were first won the pipe line men came in right behind the combat troops. Oftentimes they entered a village ahead of the infantry, it is claimed. Ten miles of pipe line per day is the average laid, but once 50 miles was completed in one day.

The sensational rush southward from Avranches by Lieutenant General George S. Patton, Jr., cast a shadow on the pipe line project, for authorities felt that fuel could be moved more quickly by trucks than static fuel lines. Now on the German frontier it is more than ever evident that the only solution is to have gasoline and oil pumped to the fighting zone. Haulage by truck was satisfactory in Burma and Alaska, but in France there is so much military road traffic that the danger of bottlenecks arose. The pipe line is equal to 1000 vehicles each day on the roads, which speaks for itself.

The system calls for pumping fuel direct from tankers. It flows through special light alloy pipes perfected in 1940 to canning stations far inland where 5-gal. fuel containers are filled for delivery to motor pools. There are no large vulnerable storage depots. Once pressure has been established by means of the chain pumping units, it makes no difference how far the line is stretched. Thus the present set-up is designed to meet every requirement of the Army in the field and can be extended into Germany.

▼ **BUYS GATHERING SYSTEM.** Arkansas Pipe Line Corporation has bought Texas Pipe Line Company's crude gathering system in the Caddo pool of North Louisiana. The Arkansas company will increase its runs from 300 to 1450 bbl. daily through this purchase with the oil going to the Arkansas Fuel Oil Company's plant near Shreveport. The Arkansas Fuel Oil is a Cities Service affiliate.

▼ **REPLACE SMALL LINE.** The Kansas-Nebraska Natural Gas Company, Inc., Phillipsburg, Kansas, has been granted permission by the Federal Power Commission to lay a 12¾-in. pipe line for 16 miles northward from Stockton, Rooks County, Kansas, to replace an existing 6⅝-in. line. The line is necessary to move an increased volume of gas from the Hugoton field in Kansas. Plans include completion of the new line this year. FPC said that no increase in company rates is contemplated by reason of the new construction. The company serves retail customers in Colby, Norton, and Phillipsburg, Kansas; Holdrege, Nebraska, and smaller communities.

▼ **RELEASE TANK CARS.** Announcement by the Office of Defense Transportation of the release of tank car control is cheering news for Mid-Continent refiners. The new rule went into effect on September 25. The bulletin, in releasing tank cars, stated that all cars held in District 1 service since December 29, 1942, might now be moved in any PAW district in the country.

During the time that tank cars have been frozen in District 1 service, many refiners in District 2 have experienced dire hardships. Relaxation of this rule will allow freer movement of gasoline from District 2 plants.

▼ **PERMIT NEW FACILITIES.** The Federal Power Commission has announced that the Consolidated Gas Utilities Corporation, Oklahoma City, Oklahoma, has been certified to provide additional facilities in Kansas and Oklahoma. It has also been authorized to abandon about 1½ miles of pipe line in Rice County, Kansas.

▼ **DOUBLE BOTTOMS CARRY OIL.** An increasingly valuable method of bringing fuel to the merchant marine is transporting it in double bottoms and fuel bunkers of dry cargo ships, a wartime innovation developed by American ship operators and the War Shipping Administration. The excess fuel carried by these vessels to world-wide destinations has supplemented tanker shipments to fueling stations by millions of barrels since 1942, and has released tanker space for increased supplies of aviation gasoline to war fronts. By allowing additional means of transport it has also aided the domestic oil crisis on the Atlantic coast.

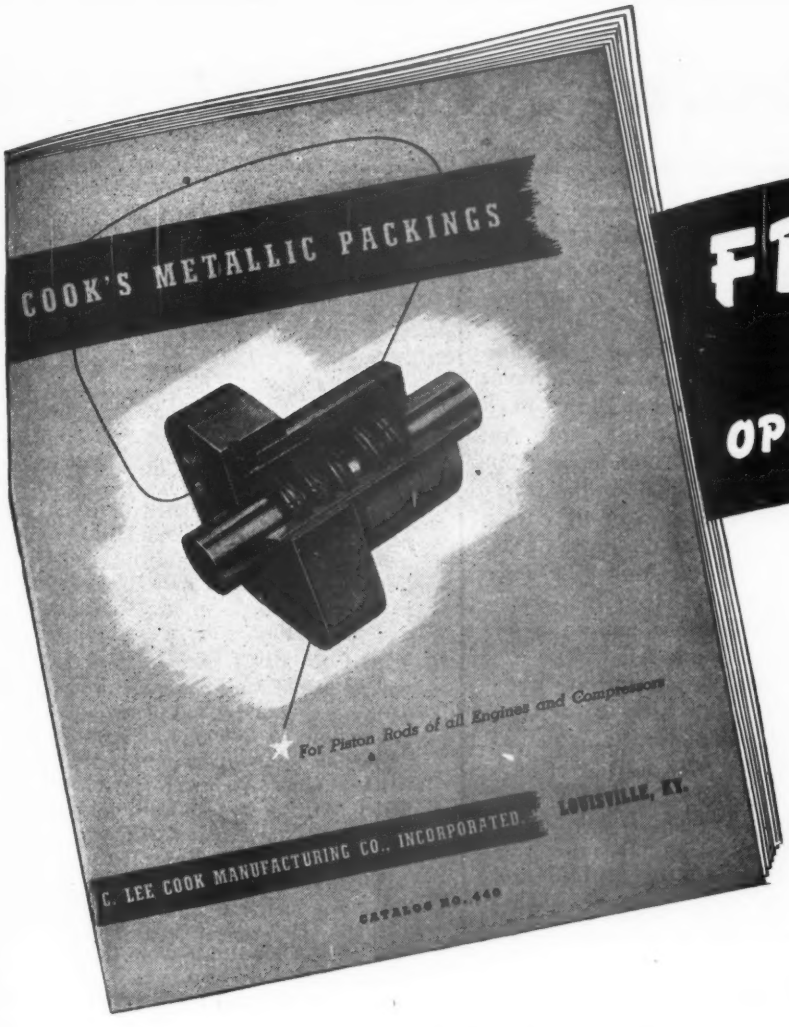
With increased shipping upon the entrance of the United States into the war, ships usually fueled only for scheduled voyages were short of available tanker transport. Ship routes with their convenient fuel depots were wiped out. Now almost every merchant ship serving the United States carries an excess of oil by loading to capacity bunkers and double bottoms. Before starting their return voyages, all fuel in excess of trip requirements is discharged at a fueling depot or transferred to other ships.

During the two-year period which the plan has been in operation more than 1,250,000 long tons of fuel were sent to England in dry cargo vessels thereby releasing 128 tankers of 10,000 deadweight tons each for other services. This year the total is expected to reach more than 15,000,000 tons.

Plan northern network

Plans for a $15,000,000 pipe line from Central Montana to Seattle, Washington, have been announced by C. O. Rison of Billings, Montana, vice president of the North Pacific Pipe Line Company. The proposed pipe line, 10 in. in diameter with 40,000 bbl. daily capacity, will be started early in 1945. In addition to the line, the venture will involve construction of $5,000,000 refinery south of Seattle and a 960,000-bbl. storage farm at Renton, Washington.

The pipe line will begin at Harlowtown, Montana, with lateral lines to fields in northern and central Montana and to northern Wyoming, and will terminate in Seattle, as plans are now laid.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MAJOR *Refining* ACTIVITIES

▼ **SET NEW RECORD.** Humble Oil and Refining Company's No. 2, Catalytic cracking unit has established a new record for continuous operation without time off for repairs, Humble officials announced. On September 14 the unit completed a 183-day continuous run to break the unofficial 182.8-day record previously set by the Standard Oil Company of Louisiana's Baton Rouge refinery. The 240-ft. giant "cat cracker" was placed on stream on March 12, and on September 14 had produced at or above capacity without interruption for 183 days. With a new world record the Baytown unit was reported "purring" along at normal stride, processing approximately 18,000 bbl. of feed stock daily from which it processes high quality aviation gasoline base stocks, butylenes, pentylenes, and other light ends essential to the manufacture of 100-octane gasoline, synthetic rubber, and other war materials.

Company officials would not hazard a guess as to how much longer the unit may operate without repairs, but they did say it had developed a "hot spot" on one side as a result of near-failure of inside insulation, and that live steam was being played on this center of potential trouble to keep it cool and in service. This was explained, however, as a rather common occurrence in the operation of these units and was not considered likely to cause a shutdown.

▼ **CONTRACT LET.** The Humble Oil and Refining Company has awarded contract for the building of its third unit of the cycling plant in the Katy area of Waller, Fort Bend, and Harris counties, to the Hudson Engineering Company of Houston. The cost will be about $700,000. Work will begin on the plant sometime early next year.

Contract is pending for construction of a large cycling plant at LaGloria, near Falfurrias, in Jim Wells County. Half interest in this plant is owned by Magnolia Petroleum Company, the other half divided between Sinclair and Transwestern.

▼ **ALL-PETROLEUM RUBBER.** The first butyl rubber to be produced in Texas came from the finishing mills of the government's new butyl rubber plant at Baytown. The new plant, known as Plancor 1082, is staffed and operated by the Humble Oil and Refining Company and was constructed for Defense Plant Corporation.

The butyl plant involves processes of recent development and produces synthetic rubber from a feed stock originating in Humble's two giant catalytic crackers at the Baytown refinery. Extremes in temperature are involved in the manufacturing process ranging from below 100°F. in the vessels where the rubber is actually formed to 300°F. in the roller mills where the rubber crumbs are converted into sheet rubber.

Butyl rubber is one of the two types of synthetic rubber produced at Baytown. The other is buna-S. The two differ in that butyl is strictly a petroleum product while buna-S is a combination butadiene produced from either petroleum or alcohol, with styrene and other ingredients produced from other organic materials. Butyl rubber is made direct from isobutylene and isoprene, both products of petroleum. The new synthetic rubber is adaptable to the production of inner tubes, rubberized cloth and similar products.

Celanese builds plant

The Celanese Corporation of America is erecting its second plant near Corpus Christi at Bishop, Texas, for the production of 10,000 tons of butadiene per year. The first plant, now nearing completion, and the new $5,000,000 unit to be constructed, are both for the commercial application of processes developed during the past decade by Celanese research specialists and chemical engineers under the supervision of Joseph E. Bludworth.

The new Bishop unit has been provided with high priorities, and its completion is expected during the first half of 1945, probably about 6 months after building is begun. It will be devoted exclusively to the production of butadiene to be used to manufacture synthetic rubber.

▼ **ODT MODIFIES RULE.** The Office of Defense Transportation has modified its revised order 7 which compelled refiners to obtain an ODT permit to ship by-products of oil into any area beyond 200 miles of the refinery. Under the new regulation, a refiner may move gasoline any distance from his plant without ODT permission. According to Mid-Continent, this means that necessity for control of oil shipments is rapidly disappearing.

▼ **COMPLETE CONSTRUCTION PROGRAM.** The 3-year engineering and construction program involving plants turning out 67 per cent of the nation's supply of 100-octane gasoline has been completed by M. W. Kellogg Company, petro-chemical engineers. The announcement came at the completion of a refinery installation project for The Texas Company at Wilmington, California. The entire program represents an investment of approximately $500,000,000 by the petroleum industry. It comprises more than 50 installations, including 19 fluid catalytic-cracking units for production of aviation gasoline.

The program, according to the Kellogg company, sets a new record for the petroleum industry. It was geared to meet the nation's demands for 3 vital war materials: high octane gasoline for aviation fuel, butadiene for synthetic rubber, and toluene and ammonia for explosives.

Chief centers of construction units are Louisiana, Texas, Indiana, Illinois, Wyoming, Maryland, California, and Utah. Some of the plants have been built in foreign nations, including Iran, Canada, and the Netherlands. West Indies.

▼ **SUPER FUEL TESTING UNIT.** A new $500,000 fuels testing unit designed to supply data for acceleration of improvement in 100-octane gasoline has been placed in operation by Standard Oil Company of New Jersey. The unit, which will cost $100,000 annually to operate, is described as the most complete unit of its kind and the first to be erected by an oil company. Tests are being conducted for the purpose of increasing efficiency of super fuels for the war and for possible use in the automobile of the future.

The new unit is a large isolated concrete structure designed for testing fuels of all kinds, including aircraft engines with more than 2500 horsepower. The engine under study is anchored to a 24-ton concrete block and run at full speed while scores of delicate instruments measure all details of power and performance of superfuels. The demonstration test used a 1500-horsepower engine on the test stand. Flight conditions were simulated. The control room was comfortable with a ventilating system providing a constant supply of fresh filtered air. This air is maintained at slight pressure to eliminate possibility of exhaust gasses from the cell leading into the control room

▼ **SYNTHETIC OIL PLANT.** Plans for a conversion plant to be built in Kansas for the purpose of producing synthetic oil have been announced by Fred C. Koch, consulting engineer. Gas from the Hugoton field in Kansas and Oklahoma, the world's largest natural gas field, will be utilized to produce the oil. The project is still in formulative stage and no site has been chosen, Koch said. The plant will be operated under the Fischer-Tropsch process, he said. It is the first of its kind in Kansas and one of the first in the United States.

The Champlin Refining Company has tentatively agreed to go into the project, Koch announced. He listed his associates as P. C. Keith of New York City, O. H. Ingram of St. Paul, Minnesota, and E. G. Bradley of Wichita, Kansas.

P 972.1

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THE Petroleum Engineer

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Edited by
Wallace A. Sawdon
Foreign Editor

OIL PRODUCTION AND ITS GLOBAL ASPECTS

By **WALLACE A. SAWDON**

EXCLUSIVE

OIL has played, and is still playing, its vital role in war. But the oil industry must prepare now for its equally vital role in peace. Although the immediate demand for oil throughout the world will probably not be so urgent after hostilities cease, the world that will emerge from this war will be more highly mechanized than the one that entered it. Industrialization will be more widely distributed over the globe and world-wide demand for petroleum products will certainly begin to increase as soon as the machines become available that those products will power and lubricate.

The existing reserve of crude oil will be adequate for the time being, but efficient production cannot long continue without extensive replacements of equipment and, in the United States at least, the discovery of more fields. The tremendous volumes of oil produced in this country during the emergency have been provided under great difficulty and frequently with harm to reservoirs because of having to produce above their maximum efficient rate.

The manufacturers of equipment and the service companies, which provide the means for exploration, production, transportation, and refining, have been doing a remarkable job. Not only have the manufacturers of oil equipment been hampered by shortages of material and manpower but they have been putting great percentages of their efforts into making war materials. Soon they will be faced with the task of reconversion of all facilities for manufacturing the products on which their future existence depends—products that are urgently needed to insure the continued production of the oil on which many other industries must rely. In other oil-producing countries this need of equipment replenishment is probably more acute than it is in the United States.

Vital in war, petroleum will play an equally important role in the highly mechanized and industrial postwar era.

According to recent reports on the condition of oil equipment in the northern South American countries where considerable reliance for increased future production is placed, tools and machinery are in bad condition. Here are needed not only new equipment but also installations of more modern designs. Some of the equipment is not in service because of lack of parts; some because of inability to put the equipment into condition. A considerable amount is being used inefficiently because the equipment is not complete or cannot be serviced. There are instances of core bits being used for straight drilling because the proper bits cannot be obtained.

Similar conditions probably exist in the Near East. In the East Indies and Burma the status of wells and plants is anybody's guess. It can be assumed, however, that in these areas and in Europe almost complete replacement of all facilities will be necessary when the Axis powers are dispossessed. Work on the plants will have to be done from the ground up; on the wells, from the ground down.

Tools and machinery of all types have been ordered from the United States, but the operators cannot get equipment because the manufacturers cannot supply it, or transportation is not available, or government restrictions will not permit its shipment. These conditions will not prevail indefinitely and manufacturers

should prepare for the demands that will be placed upon them.

It is natural that American manufacturers should have to meet these demands. The American petroleum industry uses vast quantities of oil equipment that has been developed to meet and overcome every variety of exploration, production, transportation, and refining problem. The manufacture of American equipment is based on experience and tools and machinery will function not only from the standpoint of mechanical efficiency but also from the standpoint of adaptability to meet specific applications. American equipment goes to the job ready to perform immediately with maximum efficiency and safety.

During the war it has been difficult, frequently impossible, for manufacturers of oil equipment to send representatives to foreign countries. In South America, at least, this condition has changed. American equipment men should begin to contact more closely the operators in foreign countries. The operators need the advice of these men and the equipment men need to know what the foreign operators require. The necessity for cooperation between peoples that is now beginning to be so widely recognized is just as important between makers and users of equipment, particularly in foreign fields. Competent qualified men should be sent to these fields and in addition to assisting operators in meeting their equipment and servicing problems they should bring back data on existing conditions so that instruments, tools, machinery, and plants to be supplied will be the best possible for particular application.

The supplying of oil equipment for foreign operations by American manufacturers must be in addition to meeting the domestic demand. These manufacturers will be hard pressed at first and there is the probability that they may be seriously hampered in getting materials even after the demands of war are over. When priorities are lifted there will be a mad rush to get materials for the thousand and one products that denied peoples and devastated nation are going to want. They will want oil, too, but it is difficult to make them see that metals must be used to make equipment to get the oil. They can see the automobiles, the planes, the stoves, and the structural steel that goes into new factories and buildings. They can't see the oil equipment; all they can see is the oil. Assurance should therefore be made that metals, frequently alloys developed by metallurgical research, will be made available for the manufacture of oil equipment so that oil can be discovered, produced, transported, and refined in the Americas, in Europe, in the Near East, in the Indies, and in the far-flung corners of the world yet to be initiated into the fraternity of oil-producing nations.

▼ **World activity in oil production.** Production of crude oil in the United States has touched a peak of almost 4,700,000 bbl. a day. The total production during the year 1943 was more than 1,500,000,000 bbl., or an average daily production of 4,113,000 bbl. The total production for the year 1944 will greatly exceed that of last year. During the year, the United States produced 67.6 per cent of all the estimated oil production of the world. This percentage may also be increased during the current year.

A great part of this impressive volume of oil production has been devoted to the conduct of war, both directly in combat operations and indirectly in the manufacture of war materiel for our own and allied military forces. In producing this amount of oil the United States has depleted its reserves considerably. Oil is a wasting resource; it cannot be replaced. In the postwar period the United States must therefore expend considerable effort in exploratory work, in developing secondary recovery methods, and in increasing the efficiency of primary production.

Production declined slightly in Canada during 1943 to below 10,000,000 bbl. but is expected to show an increase over that figure for 1944. A discussion of present Canadian petroleum activities is given in another article in this section.

Mexico's production showed little change during 1943, being but slightly above the 1943 figure of approximately 33,000,000 bbl. Official governmental reports for last year have not yet been received and estimates vary to some extent. Production during the current year has increased because some relief has been given to shipping and export conditions have been made more favorable.

A reconnaissance of possible oil producing areas of Alaska has been made by U. S. governmental agencies during the past year but no authentic reports on any exploratory work have been made.

Wallace A. Sawdon is a graduate of the University of Delaware. Joined the staff of U. S. Bureau of Mines in 1922, previously having been a captain in the Engineer Corps during the first World War. Later he became affiliated with the Independent Oil and Gas Company as a petroleum engineer; was engaged in consulting engineering work; was a sales engineer for The Foxboro Company, and field editor for *Oil Field Engineering*. For several years he has been Pacific Coast and foreign editor of *The Petroleum Engineer*. Has had intimate and extensive contact with the petroleum industry throughout the world. Resides in Los Angeles, California.

▼ **South America.** The northern countries of South America will play an important part in the petroleum production of the postwar world. For many years Venezuela, Colombia, Peru, and Ecuador have exported to the United States, Europe, and several Asiatic areas. Just what the distribution of crude and refined products from these countries and from the refineries on the islands of Aruba and Curacao will be cannot be foreseen at this time, but it must be remembered that industrial activity can be expected to increase in South America, particularly in the areas south of the equatorial belt.

Argentina is progressing toward its goal of self-sufficiency in petroleum production but it is doubtful that any increase in crude production can keep up with a probable increase of consumptive demand. Brazil is exerting every effort to develop petroleum production and even if an unexpected potential should be discovered, it too is going to need more oil as its industries develop. This does not mean that petroleum supplies from South American countries must be considered in equitable world distribution.

Venezuela continues the country of greatest oil production in South America. Before curtailment of shipping facilities by the war, its production in 1941 had reached nearly 224,000,000 bbl. This volume was sharply cut in 1942 to approximately 148,300,000 bbl. but increased in 1943 to 179,400,000 bbl. or 491,500 bbl. per day average. The potential shipping capacity of the country has now been increased until, with the return of considerable export facilities, it has provided for a daily war-stimulated production of more than 800,000 bbl. Assuming a possible sustained production of 800,000 bbl. a day, the annual production would be more than 290,000,000 bbl. As a matter of fact, present production under war demands could probably be increased if equipment and transportation facilities were improved. Assuming, however, that only present production could be maintained by further development and exploration, Venezuela would be the second largest producing country in the world, regardless of uncertain reports from Russia or optimistic estimates from Iraq and Saudi Arabia.

Much of Venezuela, particularly eastern Venezuela, is still in the developing and exploratory stage. A high rate of production can thus probably be sustained with productive efficiency that will not harm the fields under present standards. Actual postwar production of Venezuela, however, may be drastically affected by planned world distribution because the volume depends entirely on exports.

An overall picture of the country's petroleum operations is given in "Venezuela Moves Ahead," published elsewhere in this section. The following is a brief summary of the drilling "hot spots" of the moment. For locations in eastern Venezuela refer to the map.

Creole Petroleum Corporation is ac-

tive around and in the Jusepin field, developing and extending the productive area. The Sinclair group, Compania Consolidad de Petroleo, is drilling between Jusepin and Santa Barbara, on the Santa Barbara concession. Mene Grande Oil Company is drilling to the southwest of the Santa Barbara field.

Development work by Mene Grande continues in the Oficina area and Socony-Vacuum recently brought in a well just north of the San Tomé camp. There is also drilling activity in El Tigre, just east of the Oficina field.

To the north of this area Creole is developing the San Joaquin field. Adjoining this field on what may be a westerly extension, Socony-Vacuum is operating at Guario. In an area between Santa Barbara and Santa Rosa, Atlantic has taken over a Pantepec concession. Equipment for work here has been purchased and drilling will be done by Drilling and Exploration Company. At Los Mercedes, in a westerly direction from San Joaquin. The Texas Company has drilled several wells to depths approximating 6900 ft.

In the extreme north the Shell interests are reported to have purchased equipment for exploratory work on a concession south of the Gulf of Cariaco.

South of any production in eastern Venezuela geophysical crews are working both north and south of the Orinoco River. It is expected that some wildcats will be drilled in this area in the near future.

In the Maracaibo Lake area in western Venezuela, Creole has moved its headquarters to La Salina on the Lake. This company is active in its development of the Lake fields and is building more barges for these operations. (See "Venezuela Moves Ahead.") Mene Grande, whose concessions are water-covered strips along the shore of the Lake, has not been active in development because of lack of shipping facilities for increased crude production. The Shell interests have 10 strings active on the land areas of the Lake fields and have drilled a deep test at Cabimas about which no reports have been made.

Other Shell interests are doing development work in the Colon area and are working at La Concepcion and La Paz, northwest of Lake Maracaibo. Interest is also being shown farther to the northwest; north of La Paz the Orinoco Oil Company is actively drilling and has more equipment on order.

Richmond Exploration Company is reported to be going back in the old Coro concession west of Cumarebo. Equipment has been ordered for the operations but some road work has to be done first.

A joint venture is expected to be started southeast of the mountains that lie to the southeast of Lake Maracaibo. This is near Barinas, which lies between the mountains and the Apure River. The location is thus in the Orinoco River basin. Farther east in this basin and in the area south of Caracus considerable preliminary work of an exploratory nature is being carried on.

Colombia. Total production of Colombia increased from 10,600,000 bbl. in 1942 to 13,261,000 bbl. in 1943 but is still far below the high of 25,600,000 bbl. reached in 1940. As shipping conditions improve, production from this country should increase and though the total for this year will probably be considerably greater than for last year the true productive capacity of Colombia will not be reflected by the volume of crude produced.

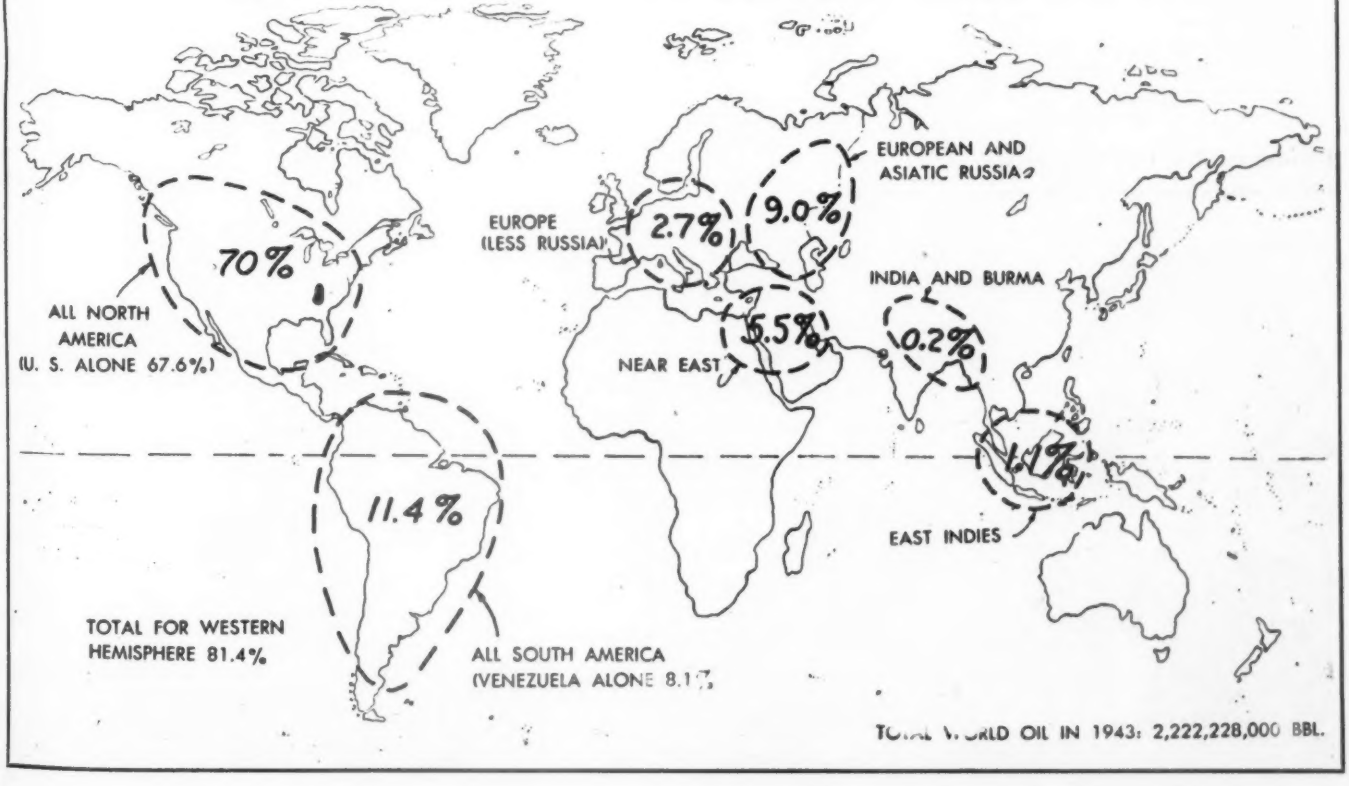
Exploratory and development work continues active in Colombia and future prospects are bright. The activities are given in greater detail in another article in this section.

Ecuador. Although the crude production of Ecuador has varied but little during the last 7 years (except for the drop in 1941 caused by war conditions) its total of 2,378,000 bbl. during 1943 is slightly higher than ever before. All this production still comes from the fields on the Santa Elena peninsula east of Guayaquil. There is, however, little activity at present in the proved fields operated by Anglo-Ecuadorian Oilfields, Ltd., or Ecuador Oilfields, Ltd. Most of Ecuador's present production comes from the Ancon field of Anglo-Ecuadorian.

There is, however, exploratory work in progress and in prospect. International Ecuadorian Petroleum Company is drilling near Zapatal, approximately 55 miles from Guayaquil. The same company has equipment in the Esmeraldas area near the north Pacific coast line and toward the Colombian border. The Shell interests are reported to have equipment ordered for work in the northeastern part of the country. The tools and machinery for operations here will be flown in.

Peru. Production of Peru continued its gradual increase of the last few years with a total of 14,654,000 bbl. for 1943. Although this is considerably short of its high of 17,500,000 bbl. made in 1937, development of the producing pools around Talara continues and appears to be accelerated at the present time. Virtually all the oil from Peru comes from

Percentages of world's total oil production by principal producing areas in 1943.



the Negritos district south and west of Talara and from the Lobitos district north of Talara, the greater portion being produced by International Petroleum Company in the Negritos fields.

Both the deep and shallow zones are being developed by International with rotary tools for the deeper and cable tools for the shallower drilling. To the north, the Campania Petrolera Lobitos is using cable tools for the development of the Lobitos area.

A rather extensive wildcat program is contemplated by International and it is reported that 6 rigs have been ordered for this work. The exploratory work will be carried on down the coast south of Talara, between the mountains and the Pacific.

Argentina. Although the 1943 production of 24,707,000 was but little more than a million-barrel increase over that of the previous year, Argentina still strives for self-sufficiency in crude oil production. It is interesting to note that, except for negligible declines in 1919 and 1930, production in Argentina has advanced consistently each year from the time of discovery in 1907. Moreover, production from government operated properties of the Y.P.F. (Yacimientos Petroliferos Fiscales) has increased more rapidly than that from private companies. Y.P.F. production is now probably close to 70 per cent of the country's total although no authentic figures for the past year are available to compute the actual percentage. Argentina's development and exploratory work has been hampered to some extent during the last year or two because of the inability to get American equipment. A number of pumping units now in service were built in Argentina. To what extent other equipment has been made in that country is not known, but some has been manufactured. What tools and machinery have been shipped in from other countries is also not known.

Trinidad. Drilling and production in Trinidad have been curtailed for some time because of lack of manpower and equipment. Increase of production of probably 15 per cent has recently been authorized so activity should be stepped up. During 1943 production was only 21,385,000 bbl., a decline of more than 16 per cent from the previous year. The 1943 production, however, was greater than for any previous year except 1942 when the highest production was attained.

▼ **The Near East.** Although the Near Eastern fields of Iran, Iraq, Saudi Arabia, Bahrein Island, and, to a minor extent, Egypt will be definite factors in postwar global distribution of petroleum and refined products, little can be said at this time about plans for development of pools and exploratory work in the countries lying on the eastern shores of the Mediterranean and extending from Russia to the southern end of the Arabian peninsula. The pipe line situation is still a matter of conjecture; also when and where any refineries will be constructed. Some of the operating companies are even changing their names.

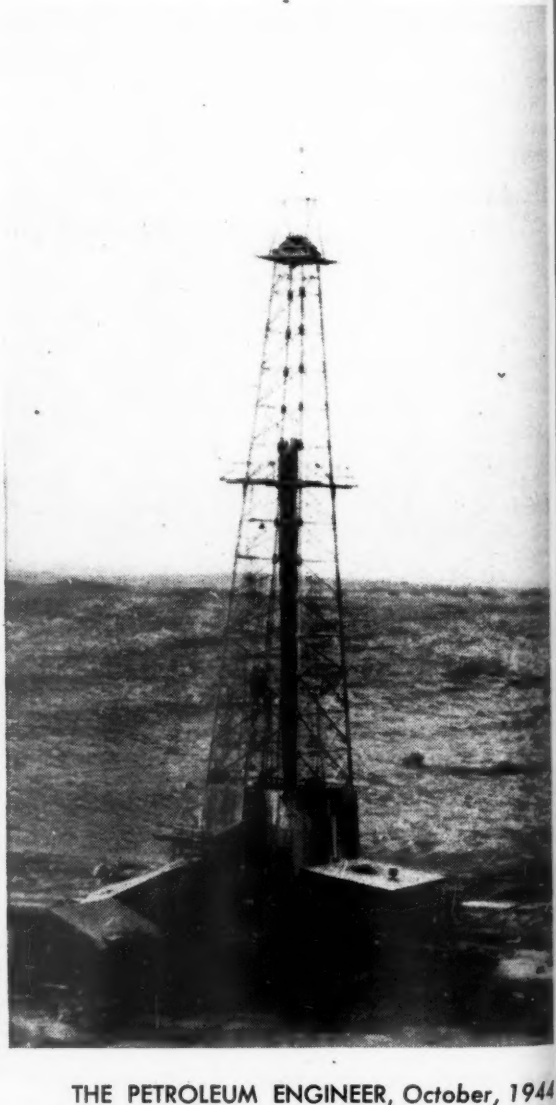
Present production does not reflect the productive capacity of the Near East. Moreover, the present known pools are not believed to indicate the probable reserves of this area. Regardless of the estimates of total reserves of the Near East, which are considered extremely great by a consensus of those who are in a position to know, production from several of the countries can be stepped up rapidly and to a great extent upon availability of equipment and manpower.

The percentage of total world production coming from the Near Eastern countries was 5.5 in 1943 and not far below the 6.1 per cent of 1939 when production from this area was greatest. The rate of production during the present year is probably higher but the percentage of the world's total will possibly decline because of the accelerated production in the United States and, to a less extent, Venezuela. What the percentage will be in postwar years cannot be foretold but it will be influenced by control of world distribution. It would not be surprising to see it rise sharply.

Iran. Production from Iran in 1943

Oil operations in Saudi Arabia are being conducted by Arabian American Oil Company, jointly owned by Standard Oil Company of California and The Texas Company. At right is the company's No. 1 Dammam Dome, the discovery well at Dammam Dome. Below is an American welder and his Arabian helpers working on tank lines in eastern Saudi Arabia.

Photography by Standard Oil Company of California



Arabian American Oil camp at Dammam Dome, Saudi Arabia.

was 73,766,000 bbl., a slight increase over the previous year. This, however, is not far below the high of a little more than 78,000,000 bbl. produced in 1938.

Iraq. An increase of approximately 84 per cent over the previous year brought Iraq's production to more than the 27,000,000 bbl. in 1943. Here, too, the greatest production was in 1938 when it reached 32,600,000 bbl.

Saudi Arabia. Production from Saudi Arabia fell to 4,865,000 bbl. in 1943 from a high of approximately 6,000,000 bbl. made in 1942. Production from this country was first reported in 1936; its present potential is difficult to estimate with the information available.

Bahrein Island. No authoritative reports have been received on actual production from Bahrein Island but from its highly developed field the production has probably remained fairly constant during the last 2 or 3 years with a possible increase to 7,500,000 bbl. during 1943.

Egypt. Production from Egypt declined very slightly to 8,953,000 bbl. during 1943. More exploratory work is expected after the European war is over.

▼ **Middle East.** Little can be said about Burma, but estimates place production from that country for 1943 at 1,000,000 bbl. This is quite a drop from the estimate of 2,500,000 bbl. made for the previous year and far from the average of between 7,000,000 and 8,000,000 bbl. that was maintained for a number of years before capture by the Japanese.

India. Although production from India is relatively small when compared to other oil producing areas, its importance due to location is obvious. The Digboi field in Upper Assam and the fields in the Punjab continue to supply some of the much needed crude for operations in India.

Total production of India again increased in 1943 to a high of 2,748,000 bbl., which was nearly 10 per cent above the previous year.

China. Lying somewhat remote and considerably to the north of the Middle Eastern fields of India and Burma, the Kansu field of China intrigues the interest of oil men. Production from this field has last been reported as possibly being more than 3000 bbl. per day from several wells below 1300 ft. drilled with rotary equipment. Operation is under the supervision of experienced oil men.

The field is situated in the interior of China, being on the edge of the Gobi Desert and northwest of the end of the Great Wall of China. The first wells were drilled with cable tools by the Chinese, but the depths then reached probably did not exceed 500 ft. Transportation is, of course, a big problem and some of the equipment now in use was flown in.

▼ **The Far East.** Except for the oil from the northern part of Sakhalin Island and a smaller amount from Australia and New Zealand, all production of the Far East is in Japanese hands. Production from Sakhalin Island, because of Russia's recent ending of her agreement with Japan, no longer aids the Japanese war effort. During 1943 this production is reported to have increased from 4,000,000 to 5,000,000 bbl. annually and there appears to be a possibility that it may be further increased under Soviet operation.

The East Indies. Estimates for the Netherlands East Indies, Sarawak, and Brunei place the production for 1943 at 24,500,000 bbl. This is an increase (over the estimate for the previous year) of 11,000,000 bbl. for the Netherlands East Indies and 1,500,000 bbl. for the Borneo fields. Using these figures, the daily production was 67,000 bbl. per day. Add to this 1,000,000 bbl. from Burma and 3,500,000 bbl. from Japan for the year 1943 and the total daily production available to Japan during that year would be almost 80,000 bbl. a day. If shipping facilities and refining capacity were available, actual crude production from the various areas could probably have been increased. Shipping has already become hazardous and refining capacity will undoubtedly be reduced by bombing. Additional crude oil production without the means of putting it to use would therefore be of no value.

▼ **Europe and Russia.** It is useless to discuss European production at this time because the present situation is not known. During 1943 the total production for Europe, exclusive of Russia, was estimated at slightly less than 60,000,000 bbl. Approximately 36,500,000 bbl. of this was from Romania. What the actual conditions of the Romanian fields are now, and how soon and how effectively they can be rehabilitated, are not known. The importance of their capture lies not so much in what additional oil they provide for the United Nations but in the amount of vitally needed oil they take from Germany. They are, moreover, in the hands of Soviet Russia, which has evidently been supplied with all the petroleum products necessary.

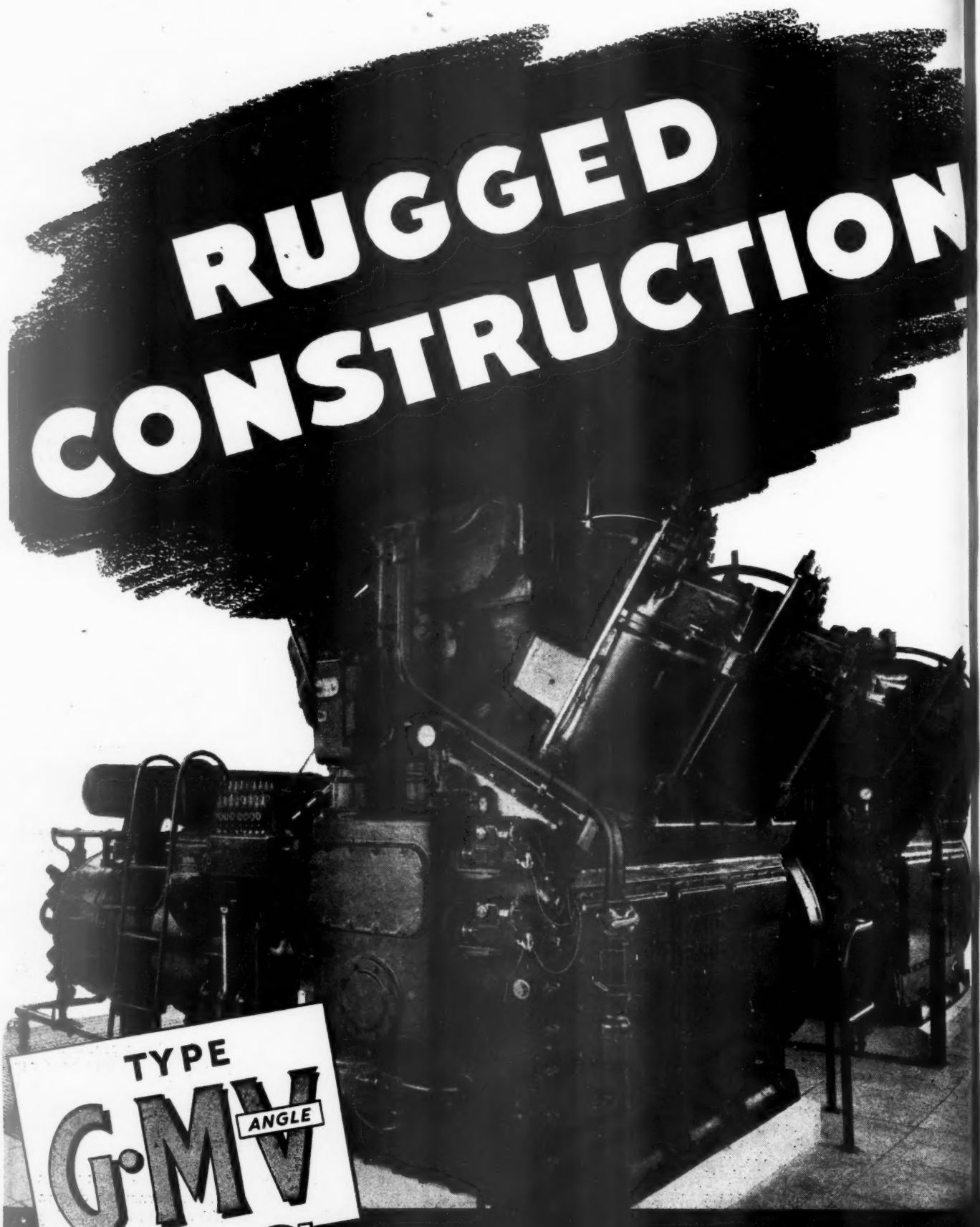
Russia. Exclusive of Sakhalin Island, the production of Soviet Russia (European and Asiatic fields) for 1943 is estimated at 200,750,000 bbl. This is a decline of a little more than 9,000,000 bbl. from the estimated production of the previous year. Activities throughout Russian fields have undoubtedly been curtailed by the war and probably little, if any, exploratory work has been carried on for some time. ★ ★ ★

New field discovered in Great Britain

A new oil field has been reported in Great Britain. The exact location of the producer has not been released by the British government, due to war restrictions. This makes a total of more than 200 wells now producing 26,000,000 gal. of high grade petroleum per year, an official announcement from London revealed.

Since the war started the largest Great Britain field has produced about 300,000 tons or about 78,000,000 gal. of oil. Described as being of excellent quality, the crude oil provides a base for high grade gasoline including aviation grades. British oil fields do not resemble the derricked landscapes in the United States. Electric pumps only 7 ft. high are used.

RUGGED CONSTRUCTION



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To give 100% performance under continuous loads, every part from base to automatic controls is designed and built to meet the most severe operating conditions—backed by the knowledge and skill of men who have been building compressors for more than thirty years.

Some important factors in the GMV's rugged strength are:

1 Meehanite Metal with its unusual strength, uniformity, and freedom from internal weaknesses is used for all parts which would normally be made of cast iron.

2 The shorter, "V"-engine crankshaft is more rigid. In the GMV, exceptionally high diameter-to-length ratio makes it all the more rugged and immune to torsional stresses.

3 Two precision-type main bearings for each crankthrow afford maximum load bearing surface and optimum load distribution.

4 The GMV articulated connecting rod design combines each compressor rod and pair of power rods into an unusually rugged, well-balanced unit assembly.

5 A patented saddle-end piston pin construction, with full-length solid bronze bearings, provides twice the bearing area otherwise possible.

6 Honed power cylinders and plated pistons are of wear-resisting Meehanite.

7 Low and medium pressure compressor cylinder bodies are of high-strength Meehanite and cast steel respectively. High pressure bodies are forged steel.

8 Incorporated into one strong, simple design, the scavenging air header, oil sump and air intake are all cast within the engine base.

by **Cooper-Bessemer**

P 991.3

Exploiting World's Oil Resources and Postwar Planning

By K. C. SCLATER, Editor

EXCLUSIVE DESPITE its pressing importance to the oil industry in long-range postwar planning, the question of an international oil policy is no nearer settlement today than it was a year ago. Violent disagreement has arisen between administrative officials and the industry on foreign oil policy. During the last twelve months, the industry has given much study to the whole problem of international oil policy and foreign oil operations in the postwar period. Drawing from its own experience, it outlined a set of basic principles and submitted it to the government for consideration in the formulation of an adequate foreign oil policy.

Ten of the country's leading oil men were called in as advisers when the agreement was being discussed by representatives of the United States Government and representatives of the British Government. The negotiators for the United States Government were all high government officials.

In August the Anglo-American Petroleum Agreement was announced. With the announcement came a statement from the State Department, which said in part: "The agreement lays down certain broad principles governing international trade in petroleum. These principles have to do with (1) assuring the availability of adequate petroleum supplies to all peaceable countries at fair prices and on a nondiscriminatory basis, subject to such collective security arrangements as may at any time be in force; (2) the development of petroleum resources with a view to the sound economic advancement of producing countries; (3) recognition of the principle of equal opportunity in the acquisition of concessions; (4) respect for valid concession contracts, and (5) freeing the production and distribution of petroleum from unnecessary restrictions."

J. HOWARD PEW, president of the Sun Oil Company, assailed the vague language of the agreement, asserting it was as innocuous or vicious as its administrators desired to make it. He saw in it a "super-state cartel covering the petroleum industry in all parts of the world for the postwar years."

Two other leaders in the oil industry, George A. Hill, Jr., president of the Houston Oil Company, and Ralph T. Zook, president of the Independent Petroleum Association of America, who sat in as advisers when the agreement was being negotiated, are among the most vigorous opponents of the agreement. The most violent opposition to the agreement became evident when it was subsequently submitted to the Senate for ratification as a treaty. Action on it has been deferred until November 14, when Congress reconvenes.

What disturbs the oil industry is that in writing the agreement, little attention seems to have been given to the suggestions put forth by the industry. What was assumed to be a preliminary agreement that would be open to thorough discussion and probable change by the oil industry suddenly became a treaty, the ratification of which by the respective governments would become binding on the oil industries of Britain and the United States. Administration officials, it would seem, are bent on some form of governmental control of, if not actual participation in, foreign oil development —witness the formation of the Petroleum Reserves Corporation and the proposed Trans-Arabian pipe line, a government corporation and a government project, either one of which threatens to make the United States Government a direct participant in foreign oil development. This latter fact is one of the main underlying causes for the growing opposition that has arisen in the oil industry to the Anglo-American Oil Agreement.

THE Independent Petroleum Association of America this month reaffirmed its resolution passed and submitted to Washington in December, 1943.

It has been suggested by the Petroleum Industry War Council and other groups in the industry that any foreign oil policy take the form of an international oil compact somewhat along the lines of our Interstate Oil Compact. As it now turns out, this is far from being the case. J. Howard Pew, head of the Sun Oil Company, a staunch advocate of a free market and of a free competitive system in the conduct of business, in a letter to Senator Connally, chairman of the Senate Foreign Relations Committee, assailing the vague language of the Anglo-American Agreement, stated that "Final acceptance of this Agreement by the United States undoubtedly would mean the establishment of a postwar federal regulatory agency for the petroleum industry in this country. The extent of the powers of such an agency, would depend upon the force which our Government would give to this Agreement. Such powers might be so wide as to supersede in virtually all respects the current petroleum policies of the several states. This in effect would mean the wrecking of our present Interstate Oil Compact, which has worked quite well.

"It has been suggested that this Agreement on Petroleum is nothing more than an international application of our Interstate Oil Compact. That is simply not so. In at least two particulars this agreement is the very antithesis of the Interstate Oil Compact.

"In the first place, our Interstate Oil Compact has as its specifically declared purpose the conservation of oil or gas by the prevention of physical waste thereof from any cause. And the Interstate Oil Compact contains the following very specific and definite declaration:

" 'It is not the purpose of this compact to authorize the States joining herein to limit the production of oil or gas for the purpose of stabilizing or fixing the price thereof, or create or perpetuate monopoly, or to promote regimentation, but is limited to the purpose of conserving oil and gas and preventing the avoidable waste thereof within reasonable limitations.'

"No such specific declaration appears in this Agreement on Petroleum. Instead, such vague phrases appear as that action should be taken 'with a view to the full satisfaction of existing demand,' and that 'the exploration for and development of petroleum resources, the construction and operation of refineries and other facilities in the distribution of petroleum shall not be hampered by restriction imposed by either Government or its Nationals, inconsistent with the purposes of this Agreement.' There again we have that mysterious phrase: *'purposes of this Agreement,'* which seemingly is related to nothing that goes before or after.

"There is, moreover, a vast difference between our Interstate Oil Compact and this proposed international oil compact. Under the former, the power of regulating production and other functions of the petroleum industry is lodged within the State governments, where it should be, if such a function is to be exercised at all. But under this international compact the power of regulating production, as far as the United States is concerned, would of necessity, be centralized in the Federal government, where under our Constitution and the American way it has no right to be, under any circumstances.

"Thus the entire system of State laws relating to oil production, refining, and distribution, built up over the years, and the Interstate Oil Compact would be destroyed. The Federal government would have an absolute power to apportion, ration or restrict production and use of petroleum products within the scope of the international allocation scheme. Such action would require freezing the position of all existing units of the industry, shutting the door against newcomers and creating a government-sponsored monopoly. It would not be long under such a monopoly before the American petroleum industry would lose all initiative and commence to disintegrate. The American consumer would be the loser under such an arrangement.

"But, it may be suggested, the negotiators of this Agreement had no such intentions in mind. It is possible they contemplated limiting whatever controls are necessary to effectuate the Agreement to petroleum products moving in foreign trade, thus leaving the American industry free insofar as its domestic business is concerned. But there is not one specific provision in this Agreement

to indicate that such is the intended course of action. If that is the plan, then it certainly should be specifically written into the Agreement.

"Of course it may be said that the effectuation of such possibilities as I have mentioned above would require subsequent legislation and appropriations by the Congress and that when such proposals are made it will be time enough to consider these broad questions. The point is not well taken. For to make agreements with other nations which we do not propose to live up to would bring upon our country the just charge of national perfidy. Such a course of action, obviously, would greatly contribute in the postwar years to international frictions and misunderstandings rather than allay them. The time to deal with these matters is when they are first brought up.

"For these reasons, as one who has devoted his life to the petroleum industry and has a deep interest in keeping it upon a competitive basis, I fervently hope that your Committee will insist that all pertinent and material facts relating to the negotiation of this Agreement on Petroleum be made public and that necessary steps will be taken to reject any effort to cartelize the American petroleum industry or to subject it to the possibility of price fixing and production controls."

SECRETARY ICKES has been quite outspoken in his suggestions regarding foreign oil policy. In a statement relating to the Petroleum Reserves Corporation, of which he is president, he suggested the kind of insurance we ought to have and that we formulate and adopt a foreign oil policy consistent with our democratic principles and with due regard to the just claims of others. He also stated that Britain had been doing this for a long time with striking benefits to itself and the British oil industry; that we ought at least to consider the working agreement that exists between the British government and the British oil industry and then adapt the democratic features of that relationship to our own situation. He went on at great length to justify the Petroleum Reserves Corporation as a government agency on this basis. In connection with these statements by Mr. Ickes, the PIWC showed "the existence of certain fundamental conceptions of fact from which there have been deducted certain fundamentally erroneous conclusions." These are:

"The British Government in truth and in fact is a partner in only one British oil corporation, viz., the Anglo-Iranian Oil Company.

"The British Government, contrary to a policy of direct engagement in the oil business, has consistently and uniformly encouraged private enterprise, and has abstained from direct engagement in any phase of the oil business.

"The policy of the British Government has been to give strong diplomatic support to its nationals engaged in the oil business in the foreign field precisely as advocated by the Petroleum Industry War Council and the Independent Petroleum Association of America.

"The British Government has never undertaken to exercise the functions of management in even this single corporation, viz., the Anglo-Iranian Oil Company, but has left the management thereof to the owners of the private interests therein.

"American interests, through private capital, initiative, management and enterprise, have acquired enormous oil interests in Saudi Arabia (within the special sphere of British influence); in Kuwait, a British protectorate; in Iraq (in the British special sphere of diplomatic influence) through part ownership of the Iraq Petroleum Company; in Bahrein, which is a British protectorate and in other British protectorates in the Middle East.

"No major development in the history of the oil industry throughout the world has resulted from purely governmental activity, comparable to the progress made in the industry by American private capital and private enterprise.

"The individual initiative and private capital of the oil industry in the United States and in the foreign field, by the use of American capital, management and materials, has been so outstanding that American companies have produced in America 64 per cent of the total world oil production from 1857 to 1943, and 67 per cent of the world total of oil production in 1943, and a substantial part of the remaining total of world production.

"The actual British relationship of Government to private oil industry in Great Britain is that of diplomatic support of British nationals engaged in private industry, as now advocated by the American oil industry of its Government, and

"The activities of the Petroleum Reserves Corporation in projecting our Government into the oil business is a positive discouragement and deterrent to the expansion of American interests in the foreign field, with a consequent disadvantage to the United States national interests."

THE industry's record refutes the idea that control by government edict is necessary. If such international cooperation is real, active, and effective in fact as well as in name, it does away with the need for control by governmental edict. Any plan of cooperation should be based on a free market, free competition, and fair practices. To make any plan workable and increase its effectiveness, provision must be made for the free and frank discussion, by the various national oil industry leaders, of international oil problems and their solution.

Foreign oil has a domestic as well as an international aspect. Oil-producing nations may at times be confronted with an oil shortage and the prospect of importing oil from other countries for domestic needs.

No more important issue has confronted the oil industry of the United States in its entire history than the problem of formulating an effective and adequate foreign oil policy. A new era of world oil development is in the offing and decisions reached now in regard to a national oil policy will have a far-reaching influence on oil development here and abroad. Oil is an important item for consideration in discussions on peace and economic security. Committed as we now are to international cooperation, some sort of international forum for the discussion of world questions on oil will be necessary.

International voluntary cooperation should be kept free of unfair tactics on the part of any company, group, or individual. Means for the elimination of friction arising from such tactics should be a matter for frank and open discussion before the international oil forum of operators. Monopolistic practices that tend to create friction and disrupt international economic relations should have immediate consideration for their disposal.

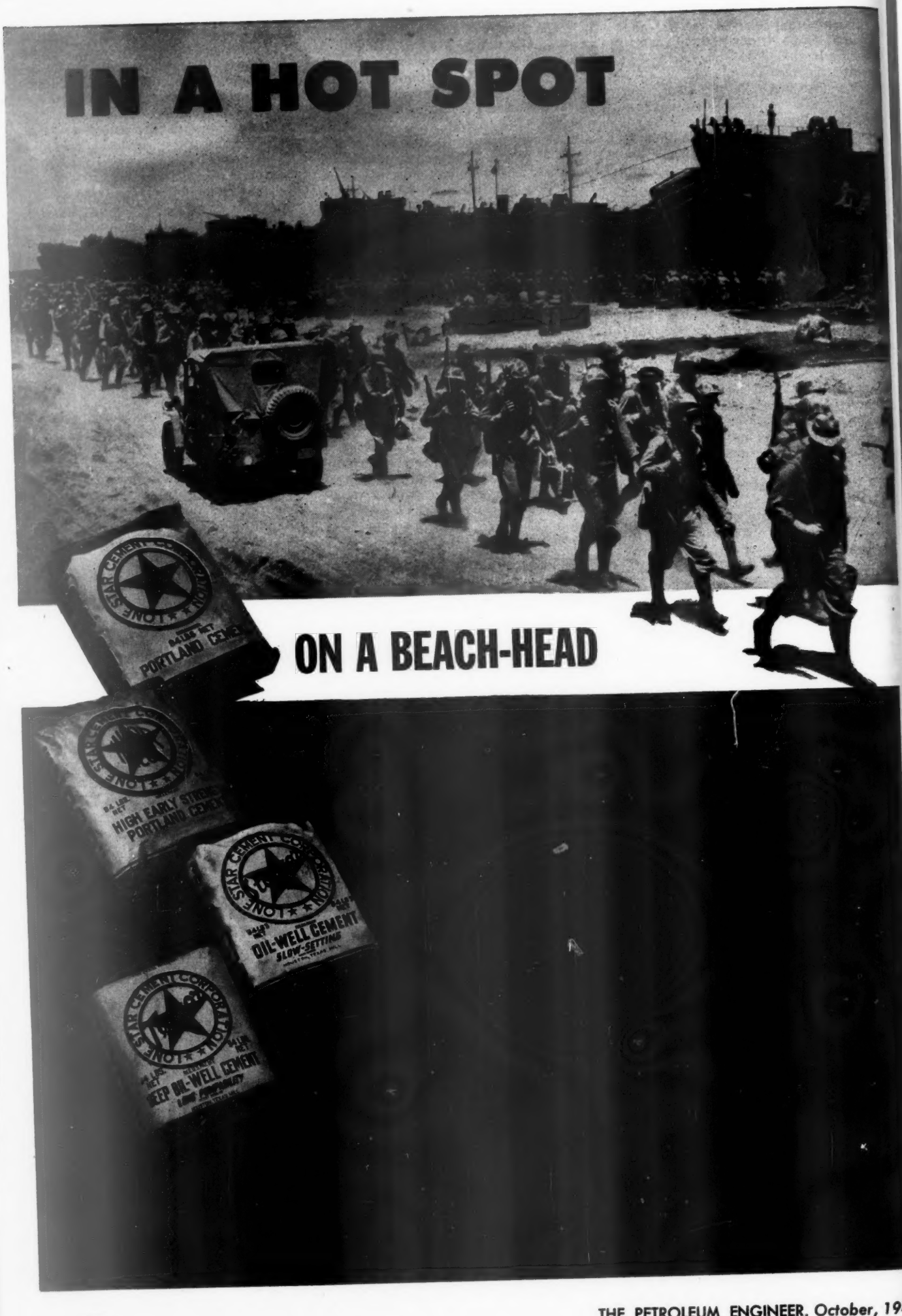
So long as the United States is pledged to international economic cooperation, it should be recognized that our foreign oil operations must fit into that of other oil-producing nations and nationals.

If the Anglo-American agreement as now written becomes a treaty it would be catastrophic. Industry would eventually be subject to strict governmental control, even in its domestic oil operations. Should the lag in the discovery of new domestic oil reserves continue—as it likely is to do under government control—the time will come when we may be compelled to depend on imported oil for domestic needs until adequate new reserves are discovered.

IT is no exaggeration to state that orderly production, refining, and distribution of petroleum and its products will be one of the important keys to maintaining peace in the postwar world. Committments with respect to international oil agreements, therefore, cannot be made lightly. They should be open to full, free, and candid discussion by all branches of the industry. It is recognized that the principles governing international trade and petroleum must be very broad until the oil-producing nations can get together. Binding agreements should be shunned until some experience is gained in closer international cooperation, such as is expected to develop in the postwar period.

Oil operations subsidized by national governments is one problem that is sure to arise. Its solution may be one of the most difficult and give rise to a host of other problems.

Long-range planning in the postwar period with respect to exploitation of the world's oil resources manifestly hinges on a satisfactory agreement on international oil policy. The Anglo-American agreement, though a preliminary document, falls far short of what is needed. If the suggestions of the oil industry are followed, it would permit the oil-producing nations of the world to coordinate their activities with complete freedom from compulsion or coercion. Such activities would include the fostering of efficient production and energy conservation practices that lead to the greatest ultimate economic production. It is to be hoped that the plan for international oil cooperation will take this form. ★ ★ ★


IN A HOT SPOT
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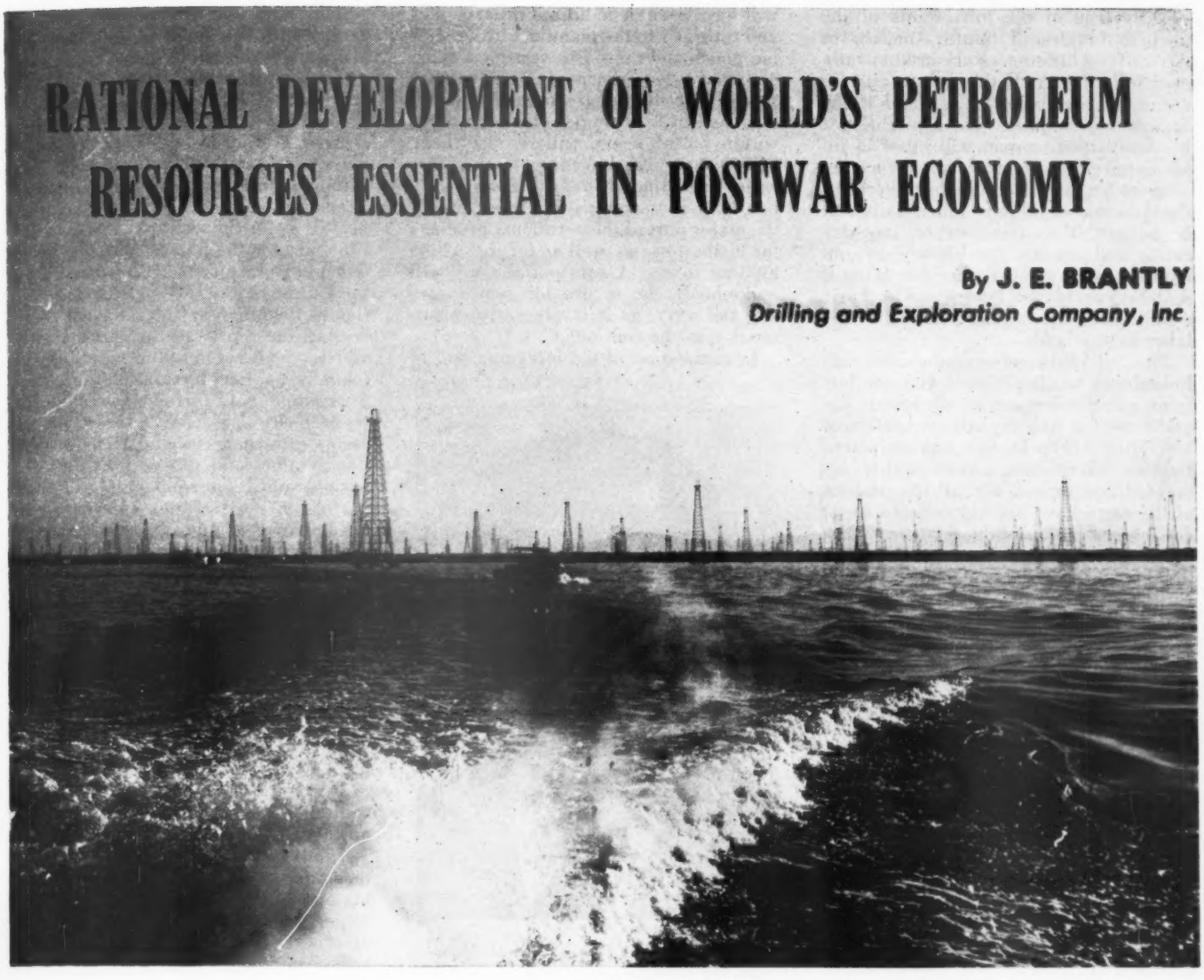
PORTLAND CEMENT
HIGH EARLY STRENGTH PORTLAND CEMENT
OIL-WELL CEMENT
SLOW-SETTING
DEEP OIL-WELL CEMENT

P 991.3

RATIONAL DEVELOPMENT OF WORLD'S PETROLEUM RESOURCES ESSENTIAL IN POSTWAR ECONOMY

By J. E. BRANTLY
Drilling and Exploration Company, Inc.



Tia Juana Field, Venezuela. ***(Standard Oil Company, N. J., Photo.)***

EXCLUSIVE THERE has been very little, if any, development of new oil reserves or oil producing capacity as a direct result of the war. All great petroleum reserves that are known today were known at the beginning of the war or were on the verge of being proved. Certainly there has been less drilling in proved areas since the commencement of war than might have been expected had there been no war. Despite the curtailment of development necessitated by the scarcity of steel for well completions, the Western Hemisphere in particular is producing oil at a daily rate of some 800,000 bbl. greater than at the beginning of the war. This production is coming from some new wells, but particularly from old wells from which increased production is being taken.

It is entirely possible or even probable that had there been no war and with normal progress in America and in the world, the demand for petroleum and its products would have equaled if not exceeded that of the present time. It likewise seems probable that the future demand for petroleum and its products in this country will show no decrease to a quantity below the maximum that its fields should produce under proper production practices. A substantially and steadily increasing demand for world consumption seems assured, except among those pessimists to whom the decline of civilization seems imminent.

Each great war brings to the fore some product of scientific and engineering skill that plays a great part in the conflict. That development is frequently, if not usually, adaptable to civilian peacetime needs and plays a major part in converting a nation or nations to a normal economy and in further promoting their economic and cultural development.

This war is world wide. The normal activities of all nations have been disrupted. These nations require reconstruction and rehabilitation and cultural and industrial expansion deferred by the war or made possible and desirable by the direct or indirect effects of the war.

After the first World War a major part was played by the internal-combustion engine in the cultural and economic development of our nation. After this war it is by no means inconceivable that the internal-combustion engine will play a major part in the economic and cultural development of the world.

This war has brought to all peoples the marvels of modern transportation effected by means of the internal-combustion engine. The people of all the nations and dependencies have been made familiar with transportation by air. Many have become acquainted with the most modern forms of road transportation and road construction and the use of the internal-combustion engine in construction, power generation, marine transportation, and for general service.

The peoples of the world have seen these things and have learned of the multitudinous advantages that they offer. They have learned that a truck can haul the load of 50 mules and that a tractor can perform the labor of a hundred bare hands. They are learning that the plane of life of a people is in direct ratio to the mechanical horsepower available for their use and that a sub-subsistence wage is all that any basic economy can allow a workman who moves soil with his hands in building a railroad, a highway, or a reservoir.

Human nature is the same among all people in that all men require the necessities of life for a satisfactory existence and all men desire those luxuries that to them make life more congenial. This is true of those who have the ability to obtain those things that a highly developed people have to offer and it is

equally true of the inhabitants of the deepest jungles of South America or Africa. The differences are in kind rather than in degree. If the opportunity for earning is available to him and if the luxuries he requires are available for his acquisition, a man will labor to fill his requirements and as many of his desires as he can. The rubber gatherer of the Amazon would have toiled daily had he been able to purchase on pay day calico and trinkets for his woman and children and those things for himself that he considered luxuries. The basic essentials of life require relatively little labor in any land.

The internal-combustion engine has brought as much progress and comfort to man in those countries where it is liberally used as has any other invention of his fertile brain. In this war its potentialities have been immeasurably increased and proved and all the peoples of the earth have been introduced to its advantages and usefulness.

It seems reasonable to assume that the demands for these machines for the various uses to which they may be put will mean for the world a fair degree of what they meant to this country after the last war.

In order that such equipment may be made available to those people who desire it, commodities for exchange must be produced by them and markets for these products, whether raw or manufactured, must be developed. This is a problem and the most important problem of the international conferences assembled for the discussion of such subjects. This international trade must involve all those commodities that may be used as media of exchange.

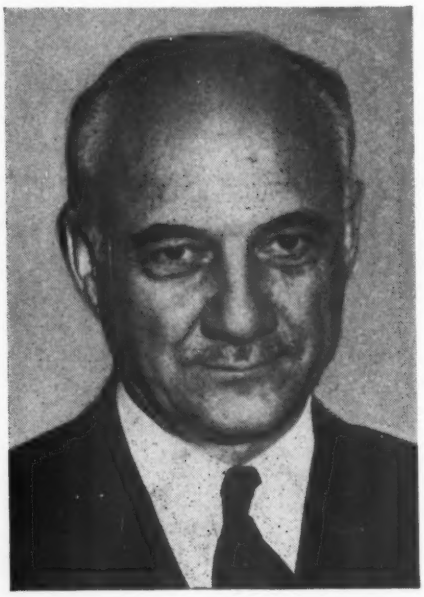
The interest of the oil industry lies in the supply, development, manufacture, and distribution of petroleum and its products. The petroleum industry is likewise deeply interested in the source of the commodity, the areas or regions of demand and the timing of the demands. These involve geology, geography, national laws, the ability of manufacturers to produce, the ability of nations to buy, and cultural and industrial development of those peoples who are backward in such respects.

At the moment the industry is concerned with the demand for petroleum products that will obtain immediately after the war. The assumption is that the European war will be won before the end of the year, but it will not be finished, for without question an army of substantial size must be retained in Europe until Germany and her once conquered territories and satellites have been restored to some degree of normality. Likewise a substantial air force will have to be maintained in that theater and many troops must be returned to this country or sent to the Pacific.

When Germany is conquered finally, there will be a concentration of effort against Japan by the navy principally, with such air power as it and the army can use. The army ground forces will likewise be employed in enormous numbers. All these efforts will require oil.

In the meantime American industry will have been demobilized in large part and returned to the manufacture of civilian goods and there is a vast market for automotive equipment in this country today. The liberated countries, which have had little or no petroleum products within recent years, will require them. This country and Venezuela, together with Asia Minor, whose delivery facilities limit its participation, must supply the major part of the petroleum products for civilian use as well as for the Allied fighting forces. A substantial army will undoubtedly be in use for some years and the navy, as it is presently constituted, must be continued.

In summation of the foregoing and in view of the "feathering off" of military demands as civilian demands increase, it would appear that the demand on this country for crude oil will not be less than the maximum quantity that can be produced under the best practices. With the rehabilitation of this country and with a normal expectancy of social and cultural advancement, it seems highly questionable that the United States shall be able ever again to fulfill its own requirements from domestic production. Hence, there can be no diminution in the search for and development of new oil reserves, either in this country or in those foreign countries in which oil does or may exist, and where other conditions render such development politically and economically feasible.



J. E. BRANTLY is a native of Georgia. He studied geology and mining engineering at the University of Alabama. Was state geologist of Georgia. At the end of the first World War, in which he saw service, he opened an office as a consulting geologist. Later, as chief geologist of the Atlantic Refining Company, he devoted much attention to geological and geophysical surveys in Mexico and South America. In 1929 he organized and has since been president of Drilling and Exploration Company, Inc., Dallas, Texas, and Los Angeles, California. In addition to activities in the United States, he has engaged in extensive operations in Colombia, Venezuela, Trinidad, eastern Canada, Peru, and Brazil.

The United States has been the great producer of oil since the beginning of the industry and has now the most extensive proved reserves of any region with the possible exception of Asia Minor. Petroleum from this country has been used for the benefit of the world as well as for the welfare of its own people and now the greater part of the petroleum being produced by the wells of the United States is being sold at a price that will not repay the industry for its cost in the tanks on the lease and for which cost it cannot be replaced. Petroleum is an irreplaceable resource and we cannot in fairness to ourselves and to posterity deplete our resources at a faster rate than is compatible with national safety and prosperity. There are nations and regions of the world where petroleum reserves are known to exist far in excess of the reasonably contemplated future requirements of the owning nation. It is from these reserves that we may reasonably expect to amplify our probably declining producing capacity, at least "declining" with respect to demand, and it is from these reserves that the oil-less nations of the world must receive their supplies.

There are other nations and regions where the areas and volumes of sedimentary formations are such that oil in quantities sufficient to provide a substantial part of, if not all, their own requirements may be reasonably expected.

The petroleum resources of the world must be developed in order that those nations that have may provide their own requirements and also supply the needs of others. It is doubtless true that no nation on the face of the earth is sufficiently wealthy that it can afford to purchase from other nations all the petroleum it could use. Therefore, it behooves those nations with known and possible oil reserves to develop them so that they will not be subject to any more of the enormous financial drain suffered when their requirements of petroleum products must be purchased abroad.

Had each nation within its boundaries sufficient quantities of the various natural resources of the subsoil and soil, or were these resources readily and reasonably available to all nations, the primary cause of wars would be eliminated. Thus the problem of those who would forge a lasting peace is a world economy under which any nation can fill its requirements in those basic commodities vital to its national happiness and peaceful existence.

Man will fight for a livelihood and for those things that he considers to be his requirements for economic and cultural development. Granting these to him, his principal incentive to war is gone.

The land areas of the world have been divided into various nations, states, and political territories by the people who occupy them or who have acquired them. The boundaries of these older political subdivisions are generally fixed by the density of population of the ethnic group that predominates in the heart of the

territory. Other boundaries have been fixed arbitrarily and still others by agreement or by conquest. Some of these political subdivisions are blessed with great stores of natural resources, some with one or more and others with the same or different ones. Others are virtually devoid of those natural resources of which national wealth might have been or may be built.

The nations or states within which these resources are found have come by them through no effort of their own but purely, let us say, through accident of birth. Some nations through intent and purpose have gone out into the world and acquired needed resources from peoples of lower cultural attainment. These resources are the products of a nature that is responsible for man as well; originally they appeared within political boundaries by chance. They, with man, are the products of one nature and no nation that possesses them has the moral right to withhold a surplus resource from the nation that has not, provided the commodity is to be used for peaceful purposes, and on a reasonable basis; nor should any nation have the legal right to do so. Only a nation that has the physical power to defy the others can withhold its surplus resources from the use of the other nations of the world, but generally that nation has become thus powerful by sharing its resources and the products of its labor with others.

In this principle there is no difference between petroleum, iron ore, coal, and the many other natural resources necessary to man in his modern culture.

The peoples of certain nations have become proficient in certain skills and industries above that of other peoples. Within those nations great industrial organizations owned by private capital and operating under individual initiative have been built. Such organizations have accomplished and are responsible for the development of the natural resources of their own nations and of the other nations that have laws permitting the entrance of foreign capital, technicians, and executives. Eventually the foreign capital and personnel become nationals of the nation of which they were formerly guests. Thus was America built. Thus was Canada built. The industrial strength of Brazil, Argentina, and other Latin American countries was similarly developed.

In the beginning of this type of industrial development by guest capital the primary objective was the development of the resources of one country for the trade or material benefit of another. This resulted in exploitation of the host country. Such practices likewise prevail at this time but the tendency is toward the domestication of the foreign interests in the host country. This is only fair and reasonable and the day is rapidly passing when capital can go into a foreign country, exploit its resources, and retire with its gains to its homeland. Those who would seek their fortunes in foreign lands should do so with these thoughts in mind—the nationals together with the capital of the host country must have a fair share in the opportunities afforded. In this are included both private and governmental interests.

Americans have become the most skillful of all peoples in the physical development and operation of the petroleum industry and American capital has played the most important part in the building of the world-wide industry. This set of circumstances has been occasioned by the fact that the modern oil industry was first developed and the oil marketed commercially in this country and because the nature of the industry is peculiarly suited to the capacities and psychology of a robust pioneer people such as we are even now. The development of the petroleum resources of the world will continue to be in considerable part, in one way or another, the problem and responsibility of Americans. Our continued success in these foreign operations will depend largely on the diplomacy and sense of fairness with which we approach those nations in which we would be guest operators.

In order that the petroleum resources of a country may be developed with reasonable facility, efficiency, and thoroughness, that country must establish laws and controls assuring the capital and operators employed that they will have uninterrupted opportunity for fair remuneration for their risks and efforts. Such laws and controls are essential in order that an exploration, developing, and operating group may justify its entrance into or activity in a country even though the physical resources and markets are known to be adequate. A consistent history of fair treatment of guest capital and operators, under fair laws, lends that confidence which encourages foreign capital to seek opportunities for industrial development in a given country. On the other hand, violations of established laws and controls or radical changes in them result in timidity on the part of foreign capital that otherwise would have been available for the development of the natural resources of and industries in the country.

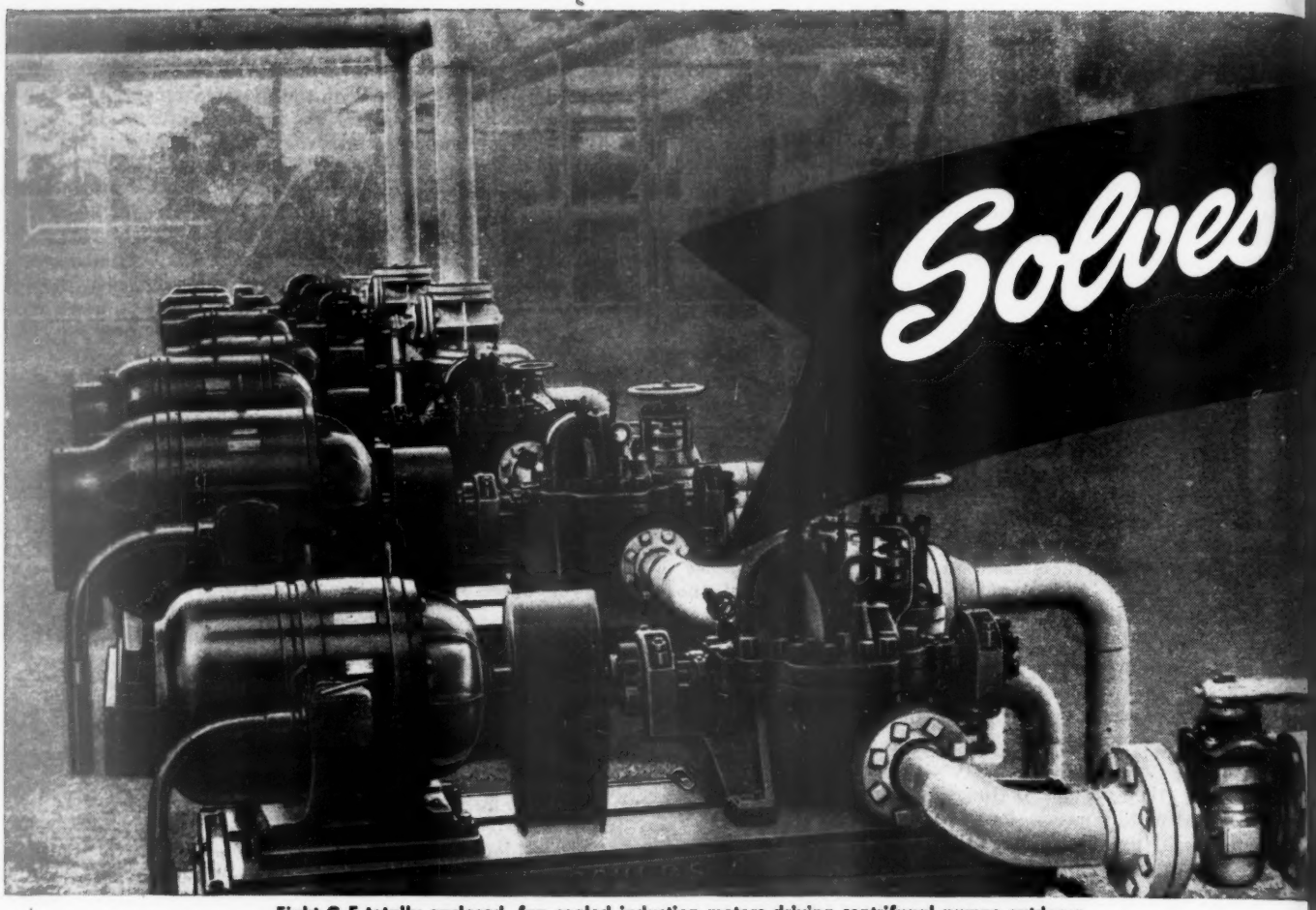
At the same time these laws must provide that a reasonable part of the produced resource or the product of the industrial development be retained in one form or another for the benefit of the nation. Otherwise its nationals are surrendering the resource, or resources, of which its basic wealth is composed without receiving those benefits that are just and fair because of national ownership. No law that does not recognize and provide for these rights can be long maintained. For this reason the operators are equally interested with the nation in the building of fair laws and controls.

A nation's basic wealth is in its natural resources and in the integrity, ability, and energy of its people. The employment offered in the development of a resource or the manufacture of a product may be of equal or greater importance to the people of the host nation than the resource or the product itself; therefore, the laws and practices of a nation must provide that its nationals have the right to participate in the works to the maximum limit consistent with efficiency of operation, if the development is by foreign capital.

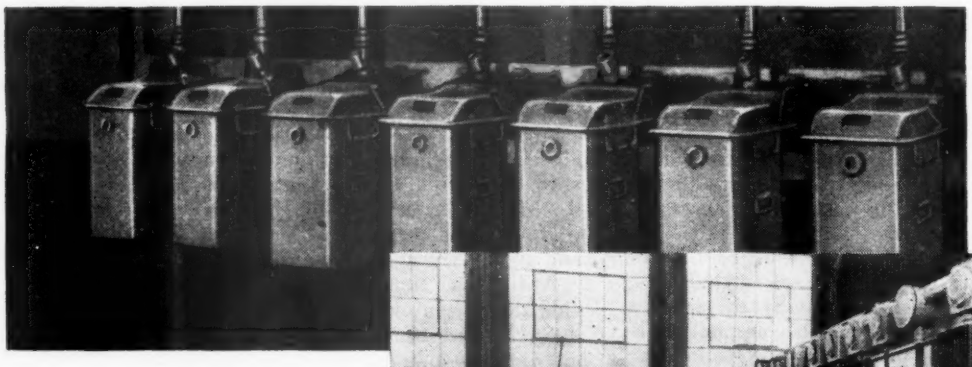
With the possible exception of Russia under its present government, all material progress, at least within modern times, has been promoted by private initiative and the successes of government sponsored projects have been assured, where they have been successful, largely through the relatively unlimited resources of the national treasury of the nation concerned. Any project sponsored and financed by private capital must of necessity be developed and operated under such conditions as to give every possible assurance of the continued and usable existence of the capital provided, together with a reasonable profit thereon. These requirements of a private venture necessitate the selection of operating personnel based solely on ability to build and operate efficiently and to earn a reasonable and fair profit on the investment; otherwise the venture will fail. Such requirements are not generally true of a government-sponsored project insofar as the selection of personnel is concerned, nor is it necessary that the project show a profit in order to survive. The final cost of the product to the people is likely to be greater under government operation. There is no reason to believe that governments of the present or of the future will be more successful in industrial developments or the development of natural resources than were those of the past. Human nature and the ambitions of man will assure this.

In recent years it has been the tendency of governments throughout the world to nationalize some industries and to undertake the development of material resources. This is particularly true in our own country with respect to vast projects for the development of electric energy, irrigation, and the reclamation of land. From the strict engineering standpoint virtually all these projects have been highly successful and in the main, regardless of whether they show a reasonable income on the investment, they were economically or culturally successful. Our government has not undertaken the development of natural resources on other than experimental or pilot plant scales.

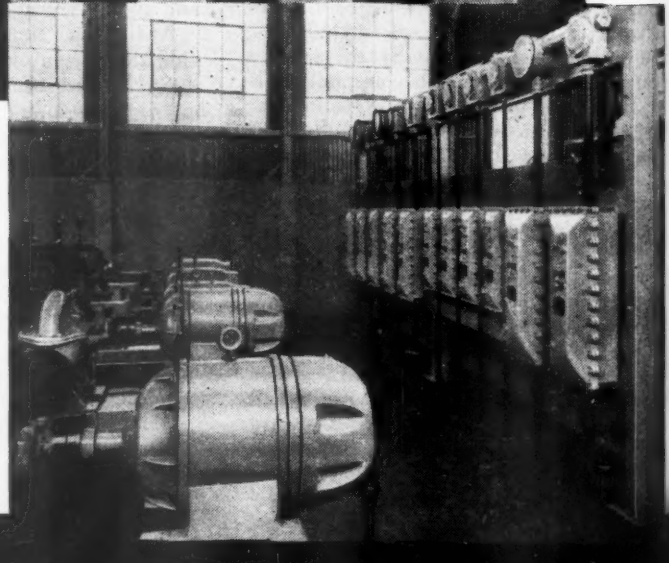
Some South American countries are making a valiant effort to develop their petroleum resources; some in competition with private capital, either national or foreign, and others where private capital has thus far declined to hazard its funds. We may not agree that the petroleum resources of those countries can be best developed by governmental effort, but if they elect that route other governmental or private interests have no moral right to interfere with, discourage, or hamper them in their efforts. After all, the country belongs to its nationals and so long as the government in power is supported by the people, and normally it must be in order to exist, those governments have the right to follow their chosen courses if consistent with the rights of other nations and their nationals. ★ ★ ★



Eight G-E totally enclosed, fan-cooled induction motors driving centrifugal pumps outdoors at a natural-gasoline plant. Squirrel-cage motors of this type are available in ratings up to 1000 hp, listed by Underwriters' Laboratories, Inc., for Class I, Group D, conditions.



Arriving ready for installation in Class I, Group D, location, rack assembly of G-E oil-immersed 440-volt combination starters. Suitable for motors up to 100 hp, these starters operate with all contacts at least six inches under oil.



Eleven G-E combination air-break starters for Class I, Group D, hazards controlling G-E explosion-proof pump motors in a gas-cycling and repressuring plant.

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for Hazardous Areas

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Explosion-proof motors and suitable control eliminate the need for special isolation to meet hazards—both explosion and corrosion.

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Whether it's high-octane gasoline, toluene, natural gas, acid fumes, or outdoor service, there's a way to meet your conditions with a combination of G-E motors and control. For General Electric builds the most complete line of motors and control devices for use in Class I as well as Class II locations.

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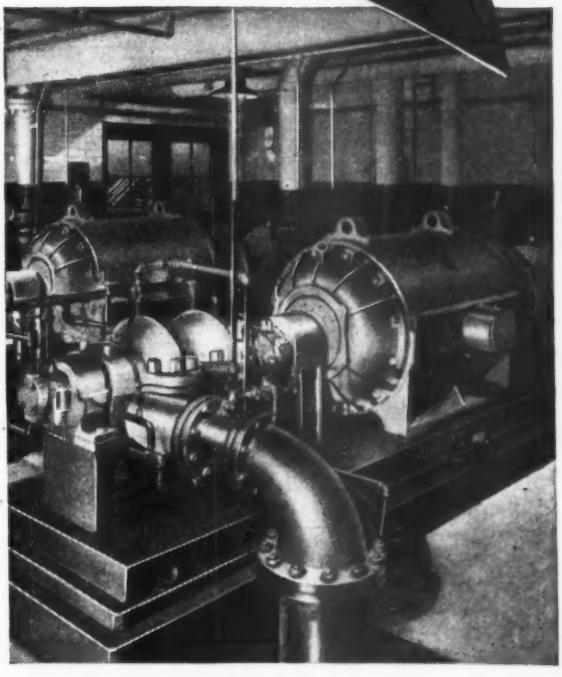

Two 250-hp, 3000-rpm G-E explosion-proof, squirrel-cage induction motors powering cold-crude-oil charging pumps. G-E wound-rotor and solid- and hollow-shaft vertical motors are also available in explosion-proof construction.

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COLOMBIA IS ACTIVE BOTH IN DEVELOPMENT and EXPLORATION

By **WALLACE A. SAWDON,** *Foreign Editor*

Production this year may exceed high record of 1940, before tanker shortage forced reduction.

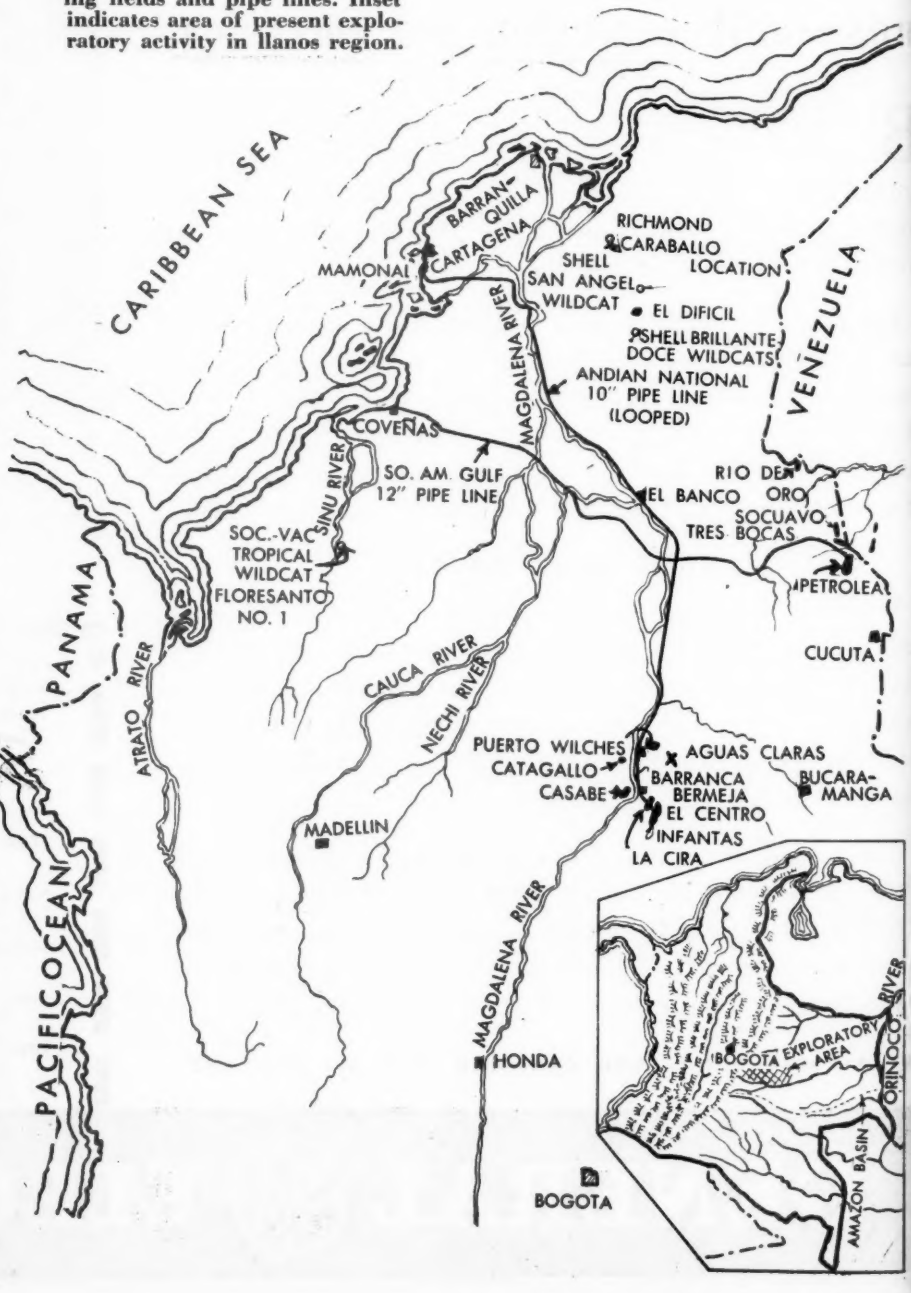
EXCLUSIVE DESPITE shortages of equipment, wildcat drilling has continued active in Colombia. Individual well operations of nearly all companies obviously have been hampered by lack of parts and the necessity for using much worn-out equipment, but operators have done the best they could under the circumstances. Future exploratory work, however, is expected to be accelerated as soon as possible and several companies that have not yet been actively drilling are making definite plans for immediate operations although in some cases considerable geophysical work has to be done first. Areas to be explored include the llanos in the southern part of the country as well as the northern areas in which all commercial production to date has been obtained. (See map.)

Companies that have been drilling development or wildcat wells, or both, during the last year are the Tropical Oil Company, which is operating the oil fields of La Cira and Infantas up the Magdalena Valley; Colombian Petroleum Company, operating the Barco concession with production at Petrolea, Tres Bocas, Socuavo, and Rio de Oro; the Shell interests with production at Casabe and El Dificil and with active exploratory work in the northern area and the llanos; Socony-Vacuum Oil Company, Inc., with a little production at Aguas Claras and several wildcats in progress, and Richmond Petroleum Company of Colombia, which has drilled several exploratory wells. All these companies, with the possible exception of Colombian, are also doing geophysical work at the present time, as is also The Texas Company. The Gulf interests are contemplating immediate seismograph surveys and several other companies are expected to do geophysical work in the near future. Phillips Petroleum Company has taken over the properties of Benedum-Trees and Leonard Oil Development Company near Simiti, which is on the Magdalena River about half way between Puerto Wilches and El Banco. Plans for testing this property have not been announced.

Production from Colombia has been reduced drastically for more than two years by the shortage of tankers. This condition is improving, in fact has improved considerably, and it is estimated that production for the first half of 1944 was almost as great as for the entire year of 1943, slightly more than 13,000,000 bbl. Should this rate of production be maintained, the total for 1944 would pass the high of 1940 when the total was nearly 25,600,000 bbl. Both pipe lines carrying oil to tidewater have terminals on the Atlantic side of the Isthmus of Panama, however, the European war will naturally have an influence on the demand for Colombian production.

In considering future production from Colombia, several factors have to be taken into account. The present potential of producing fields undoubtedly exceeds export facilities. The two greatest productive areas are served by long pipe lines (see map), which have a combined total capacity of nearly 30,000,000 bbl. a year. The South American Gulf line is 12 in. and has a capacity of approximately 25,000 bbl. a day. Although the Andian National line is 10 in., it is so looped by 10-in. pipe that all but 7 miles is a double 10-in. line and has a capacity of more than 50,000 bbl. a day. Crude oil produced by the La Cira and Infantas fields, which this line serves, does not, however, enter the line. Whatever is necessary to supply Colombia's

COLOMBIA: Showing producing fields and pipe lines. Inset indicates area of present exploratory activity in llanos region.



demand for refined products goes to Tropical's refinery at Barranca Bermeja from where finished products are shipped to various parts of the country. The rated capacity of this refinery is 14,000 bbl. a day but this can probably be exceeded considerably when desired. The average throughput has been less than capacity during the last few years. A 500-bbl. refinery in the Barco supplies only local needs. The combined throughput of these plants must, however, be considered when estimating the production of the country because the oil sent to them is in addition to export demand and pipe line capacity.

The two pipe lines are not connected with all the productive fields of the country and although more fields will probably be connected to both lines, there is always the possibility that other fields will be served by lines of their own, particularly those that are comparatively near tidewater. Economic considerations and amount of production will naturally govern when such lines are to be constructed, as in the case of the El Dificil area where fields other than the present El Dificil pool itself are hoped for. Other fields, such as the prospective one on the Sinu River, may be discovered and require additional lines. If and when oil is discovered in the llanos in the southeastern part of the country, the transportation problem becomes more difficult. Between this area and the Pacific Coast are mountains; between it and the Atlantic is the long water route of the Orinoco River to the north and the much longer Amazon system to the south.

It is reasonable to expect Colombia's potential production to be increased during the next few years. The amount of oil actually produced, however, depends on export. What will be the demand for Colombian oil in the postwar years? And how much will it be affected by planned world distribution?

▼ **Present drilling operations.** There are a great many exploratory wells planned for the next year or two in Colombia but only the developed areas and those in which test wells are being drilled or are to be drilled in the immediate future will be discussed here.

El Centro. All work by Tropical in the La Cira and Infantas fields consists of clean-out operations at the present time. Both have been drilled up and are supplying oil to the Andian National pipe line and to the refinery at Barranca Bermeja.

The Barco. The Colombian Petroleum Company conducts all operations on the Barco concession. The Petrolea field, which consists of three domes, is a settled area and is connected to the South American Gulf pipe line with tidewater terminal at Covenas. Other fields in the Barco have not yet been connected to this line but probably will be when material is available.

North of Petrolea are the Tres Bocas and Socuavo pools. Drilling is as active as possible under equipment conditions and further development will probably be intensified when tools and machinery become available. Just what the subsurface conditions are in this area still have to be defined because the productive limits are not known nor is it certain that this is not one structure. Two zones are producing, one at depths from 4500 to 5000 ft. and the other from 8500 to 9000 ft. A camp is to be constructed between the two areas and will be called Tibu. This area itself is productive and forms part of the one large field that may become known by the name of the camp, Tibu.

There is no present activity at the Rio de Oro field on the north edge of the Barco concession but this may also be connected with the pipe line to Covenas when materials are not so scarce as they are now.

Casabe. More than 20 wells have been completed by Shell in this field at depths ranging from less than 4000 to more than 7000 ft. Development work is active here but more drilling of the deeper wells will probably be delayed until heavier equipment is on hand. No outlet to tidewater has yet been provided.

El Dificil. Shell has completed three wells in this field and a fourth is drilling. Depths average between 5500 and 6000 ft. No plans for transporting the crude have yet been disclosed.

To the north of El Dificil, Shell is drilling a second wildcat on the San Angel concession. A first well, several miles to the south, got a little gas and oil and the gas is being used for fuel. The first well is reported to have gone below 9000 ft.

South of El Dificil, Shell has drilled three wells in only one of which showings were picked up. A fourth well is now drilling. These wells are on the Brillante-Doce concessions and two of the wells are reported as having gone below 10,000 ft., one to basement rock.

Richmond has been drilling south of the Shell Brillante-Doce wells, but to date has not obtained production. No new locations on this concession, Retiro, have been reported.

Aguas Claras is the headquarters for Socony-Vacuum, which has been active in this area for a number of years. Three wells had been drilled on the Las Monas structure to the east and one of these pumped small amounts of oil. Socony then drilled the Narino wells on the old Restrepo concession. About a year ago the company got a producer on the Cantagallo concession (formerly Comitarra) near Puerto Wilches, One well drilled since has not been completed because of lack of material. Another is drilling at present and still others are planned. The depth of the producing well was approximately 6000 ft. Other wells on a concession east of the river are planned for the Aguas Claras operations.

Sinu River test. A joint Tropical-Socony-Vacuum test is being drilled by Socony near the Sinu River and 50 or 60 miles from its mouth. According to reports, showings were obtained at shallow depth. After setting equipment to protect against possible high pressure conditions, the well resumed drilling.

Llanos region. Considerable activity is being shown in the llanos region, particularly just off the mountainous area southeast of Bogota. At least four of the major companies are doing geophysical work both in the exploratory area indicated on the accompanying map and farther to the south, some even reported as far as the Putumayo River, which forms the southern border of the country. Other surveys are to be made near the Ecuadorian border near Ipiales, which lies in the hilly country above the llanos.

The first test to be made in the llanos region is Shell's San Martin well, which is located down from the slope of the mountains southeast of Bogota. This test has been drilling with a light rig that was hauled in over the mountains by road. It is now probably below 2000 ft. in depth.

It is reported Tropical has purchased equipment for a test in this exploratory area and that it is contemplating hauling the equipment up the Orinoco River.

★ ★ ★

Colombia supreme court reverses oil decision

The supreme court of the Republic of Colombia, sitting at Bogota, has handed down a unanimous decree allowing Tropical Oil Company of Pittsburgh, Pennsylvania, a subsidiary of the International Petroleum Company of Toronto, Canada, a five-year extension on concessions in Colombia. Under previous orders, the concession would have expired August 25, 1946. The new ruling, a popular one, will extend the date until August 25, 1951.

It is inferred that the decision, written by Justice Victor Cock, and agreed to by the other members of the Colombian supreme court will permit Tropical to pursue the orderly development of its properties, seek additional reserves, and be in a position to negotiate before 1951 for the right to operate the properties for the Colombian government.

Oil men agree that the Colombia decision extending the Tropical concessions of the Barranca Bermeja field is an important ruling and will tend to accelerate the interest of American firms in obtaining Colombian concessions. The ruling invoked a clause in the original negotiations that began in 1905 asserting that when Tropical's concession does terminate, the fields it has developed together with all facilities would become the property of the Colombian government.

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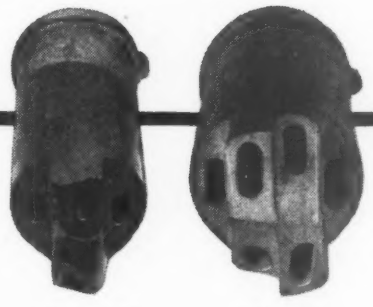
The construction of Reed Rock Bits provides a strong, safe foundation for the cutter assembly and all cutter teeth and gauge bevels are hard faced for longer life, full gauge hole and more hole per bit.



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VENEZUELA REFINERY CAPACITY 70,000 BARRELS CRUDE DAILY

By **L. R. KIRSHEMAN**, Standard Oil Company (N. J.)
Foreign Refining Department

EXCLUSIVE CREOLE PETROLEUM CORPORATION, for many years an important South American affiliate of Standard Oil Company (N.J.), was expanded greatly in the latter part of 1943 by the acquisition of the properties and activities in Venezuela of Lago Petroleum Corporation and Compania de Petroleo Lago, and by the absorption of Standard Oil Company of Venezuela, formerly its wholly owned subsidiary. This desirable simplification was carried out following a revision of the Venezuelan petroleum law, which became effective in March, 1943, and which rendered possible the conversion and reissuance to Creole of the concessions formerly held by these separate companies.

Creole's activities in Venezuela are largely concerned with the production of crude oil although it also operates refining facilities to supply the bulk of the refined products marketed through its sales outlets and a considerably larger volume for export. Geographically,

Creole corporation plants supply large share of the daily 11,800 barrels of products distributed in Venezuela alone.

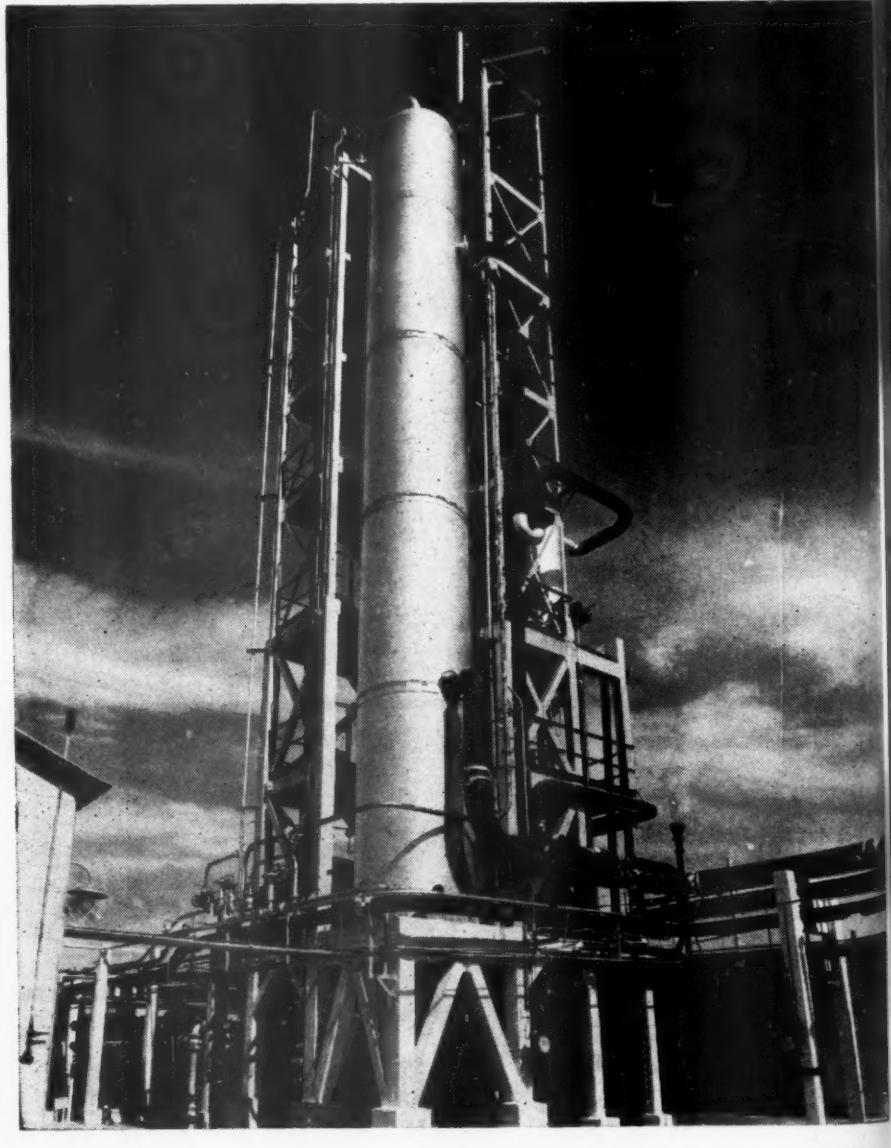
Creole operates from the Orinoco delta, in the extreme east, to the Lake Maracaibo Basin in the western part of the country. Total crude production in Venezuela during the first quarter of 1944 was 566,000 bbl. per day of which Creole accounted for 334,000 bbl. per day. The crudes produced by Creole cover a wide variety ranging from 17.5° API Lagunillas crude from the Lake Maracaibo district, a source of high quality asphalts, to the very paraffinic 49° API Cumarebo crude, which gives high yields of naphtha and an excellent illuminating kerosine. Some of the crudes are valuable as sources of high octane base stocks for aviation gasoline and others yield a large percentage of prime quality (50 cetane number) diesel oils, which are also of great importance in the war effort. Some of the eastern crudes have proved to be rich sources of paraffin waxes and are imported into the United States in considerable quantity to augment the local wax supply.

At the present time, refining facilities in Venezuela total 70,000 to 75,000 bbl. per day crude capacity divided between Creole and Caribbean Petroleum Company, a Shell affiliate. In addition, the Mene Grande Oil Company, controlled by Gulf, operates a small topping plant at Cabimas to supply products consumed in their crude producing operations. The Creole refineries are at Caripito, in the state of Monagas in Eastern Venezuela and at Cabimas, in the state of Zulia on the eastern shore of Lake Maracaibo.

▼ **Caripito operations.** Caripito Refinery, completed in 1939, consists of a combination crude topping and visbreaker unit with integral gas absorption and light ends stabilization facilities. Although normally run on 19° API Quiriquire crude at a capacity of 39,600 bbl. per day, it has processed 33° API Jusepin crude and at the present time alterations are being made so that both of these crudes may be processed simultaneously. Products include gasoline (leaded to 70 ASTM octane number and dyed orange), kerosine, light and heavy diesel oil, navy special and heavy bunker fuel oils; special light cuts are also made for finishing at other Caribbean area refineries to augment production of aviation gasoline. Equipment at Caripito includes a powerhouse having two 500 kva. turbo generators, with an additional unit proposed. Electricity is supplied not only to the refinery but also to the nearby producing field at Quiriquire. Products are shipped to deep water by shallow draft vessel down the San Juan River on which the refinery is situated, some 65 miles from the Gulf of Paria.

▼ **La Salina operations.** The La Salina refinery at Cabimas was originally constructed in 1926-1927 to supply products for the local crude producing operations. Its output was later increased to provide for the needs of the rapidly growing Venezuelan market. In 1939, a modern

La Salina Refinery
Standard Oil (N. J.) Photo



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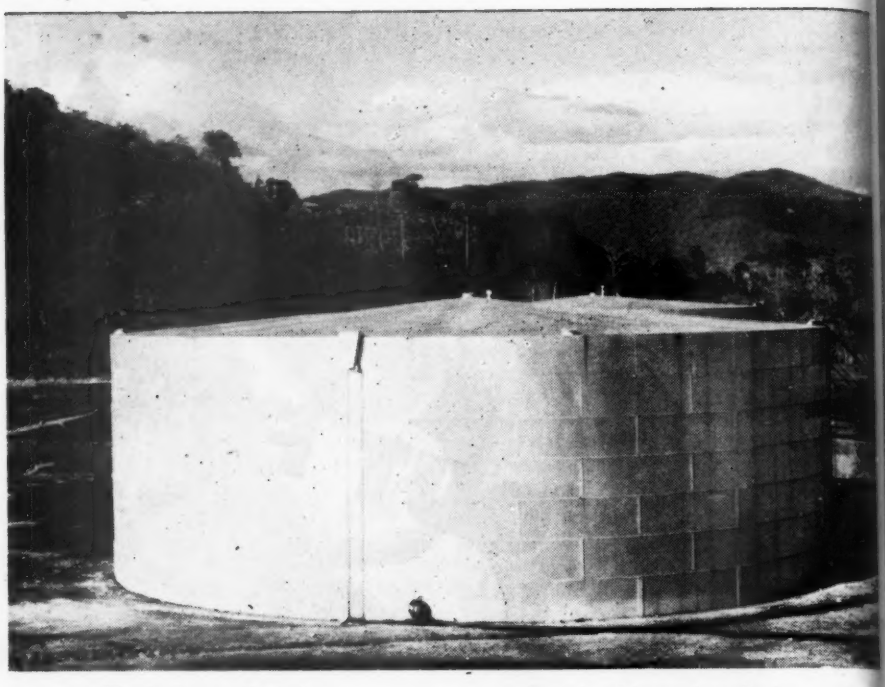
pipestill was erected by the Foster Wheeler Corporation to augment the capacity of the two home-made pipestills, which had served since 1927 and were finally dismantled in 1941. The new Foster Wheeler unit was designed to process 5000 bbl. per day of medium Lake crude (25° API) for naphtha, kerosine, light diesel and fuel oils, or alternatively, 10,000 bbl. per day of 17.5° API Lagunillas crude for gasoline and fuel. Both of these capacities have been exceeded in practice and, in addition, the still has processed Lagunillas crude at 3500-4000 bbl. per day for asphalt production. The asphalt base is blended with heavy naphtha diluent to produce asphalt cutback, in which form it is transported to bulk installations at Maracaibo, Puerto Cabello, La Guaira, Puerto La Cruz, and Caripito. Another product now made at La Salina is Varsol, a turpentine substitute and cleaner's naphtha.

Total outlet for products in Venezuela currently amounts to 11,800 bbl. per day, of which Creole has a substantial share. Business is steadily growing, particularly in kerosine, which is distributed in ever increasing quantities, even by burro-back, to remote mountain districts where it is not only used in lamps but to some extent has replaced charcoal as household fuel for cooking purposes. In replacing charcoal, kerosine helps indirectly in soil conservation by removing the incentive to cut down mountain forests, a practice that has resulted in considerable erosion in some districts.

Asphalt sales, previously mentioned, are looked upon as another factor in the development of the country. Not only has this product been used to pave the major airports at Maracaibo, La Guaira, and Maturin but is being employed to an increasing extent in the pavement of roads and streets. The Martin Engineering Company in Maracaibo recently completed the paving of Bella Vista Boulevard, one of the principal thoroughfares of that city, and has expanded this work to many roads in the vicinity. It is also paving a large section of the city streets of Valera, in the state of Trujillo. In the east, some of the highways near Caripito and Guanta have been paved with asphalt and many travelers have favorably commented on the improved road surface provided by this product, especially during the heavy rains, which are prevalent in this region during certain seasons of the year.



Tank farm, Caripito
Standard Oil (N. J.) Photo

▼ **Employees and families.** It would be inappropriate to omit mention in this article of the close collaboration between the company and the government in providing up-to-date housing and medical and educational facilities for its employees and their children. In most cases the crude-producing camps and refineries are in the midst of virgin jungle, as in Caripito, or in semi-arid regions, as in the Maracaibo Basin, where tremendous efforts must be made to establish and maintain modern standards of sanitation and hygiene. These efforts have met with enthusiastic response and their effect is plainly visible in the health and happiness of Creole's employees. Modern grade schools have been established at each of the major camps and there are graduated each year an increasing number of healthy boys and girls who will have a major share in building the Venezuela of the future. The company is interested in their further progress and, for some time past, has been studying cooperative projects for the installation of trade schools. As a matter of policy, the company endeavors, to the greatest extent possible, to fill its higher as well as lesser skilled positions with Venezuelans and to this end has given financial assistance in higher education to many technical graduates who wish to continue their studies in the universities of both Venezuela and the U. S.

In close collaboration with the government, since 1941 under the presidency of His Excellency, Isaias Medina-Angarita, the oil companies are constantly endeavoring to expand their output and to improve working and living conditions of their employees. As a result of commitments undertaken by a number of the oil companies, it can be confidently expected that the refining capacity of Venezuela will be considerably expanded as soon as materials become more readily available. ★ ★ ★

U. S. S. R. reconstructs Kuban oil development

The Kuban oil area in the Soviet Union, recovered by the Soviet forces in the spring campaign of 1943, is being brought back into production, and developments indicate that by the middle of 1945 this region may again rank among the important ones in the country, according to the Russian press. Before the war the Kuban district is said to have yielded 3,000,000 tons of oil annually, the industry giving employment to 20,000 workers. Before the German occupation, which actually lasted only a few months, installations were so thoroughly destroyed that the enemy was unable to obtain any oil from this source. When the Soviet authorities reoccupied the area, they found it necessary to reconstruct rather than recondition the installations.

Fifteen new wells were drilled by the Krasnodar Oil Combine, which is now operating 19 wells. Almost all surface installations, including compressors, pumping stations, 80 kilometers of pipe line, and 150 kilometers of pumping system have been reconstructed, as well as the water-pipe system and the first section of an oil refinery. Preparations for a cracking plant are now being made, it is said. Although output is still small, authorities believe that July 1945 production will be 12 times that of April 1944.

The Kuban deposits, stretching from Maikop to the mouth of the Kuban River and to the Taman Peninsula, are credited with being the third largest in the Soviet Union, ranking after Baku and Grozny. Kuban crudes, except those from the Taman region, are said to contain 52 per cent light fractions and yield the highest percentage of gasoline of any Soviet crudes. They are reported to be largely free from sulphur.

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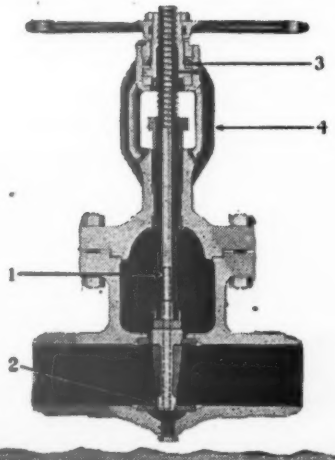

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EDWARD *Steel* VALVES

HIGH PRESSURE PRODUCTION IN PUNJAB PROVINCE, INDIA

By KARL B. JAUMAN

EXCLUSIVE THE first well successfully completed in the deep 7400 to 7600-ft. zone of the Dhulian field, India, was No. 7, which barely scratched the pay formation but produced approximately 650 bbl. per day. The second, No. 8, also barely scratching the sand, made 700 bbl. per day. The third, No. 11, penetrated the sand somewhat farther and made 5000 bbl. per day on initial production test. The next, No. 10, drilled a little deeper into the productive zone and was good for 6500 bbl. per day. The wells were brought in barefooted.

A very noticeable fact was that at intervals of approximately 15 ft. there would be a hard streak; breaking through this would cause the production to increase appreciably. For example, the upper part of the producing zone would be good for 600 to 700 bbl. per day. Drilling through the first thin hard streak, production jumped to 2000-2200 bbl. After penetrating the next thin hard streak production reached 5000 to 6500 bbl. per day. The two latter results were obtained in wells No. 11 and No. 10, respectively.

Because of lack of proper storage and refining facilities as well as marketing outlet at the time, it was necessary to bean down these wells to such an extent that the possibility arose of having to shut at least some of them in completely. The extremely high pressures involved, however, made it necessary to install surface hookups and all fittings that would be proportionately adequate. Two 8-in. master valves with controls 100 ft. or more beyond the derrick were attached directly above the 7-in. flush joint casing. The master valves were separated by an 8-in. cross.

Extending from each side of the cross were 8-in. by 3-in. swaged nipples to each of which were attached two 3-in. valves and a tee or cross. Rising from these tees or crosses were short nipples and ring-type flange unions from which lines continued upward to above the cellar where they were multiple manifolded with the following: Two outlets from the upper 8-in. gate, line to the ditch, line to shale traps, line to hydraulic ram, line to pumps, to bleeder manifold, to one or more bean-controlled production manifolds above the derrick floor, and to two flare lines (usually 6-in.) leading in opposite directions and extending to points at safe distances from the well.

Directly above the two permanent master valves the regular high pressure drilling hookup was installed including chamber, cross, hydrostatic head and drilling packer. Outlets from the upper cross were tied in with the lower cross hookup as well as directly to the ditch. Lines also led directly from production manifolds to a series of gas traps and gauging tanks. Production or return circulation could be routed as desired.

In the Dhulian field tremendous volumes of water were encountered at various depths and a number of wells had to be drilled over a number of years before successful completions were achieved. A logical theory advanced concerning the possible cause of such unprecedented volumes of water in the Dhulian field and excessive water pressures in Khaur field was that the conditions might be due to the proximity to the Himalaya and other high mountain ranges.

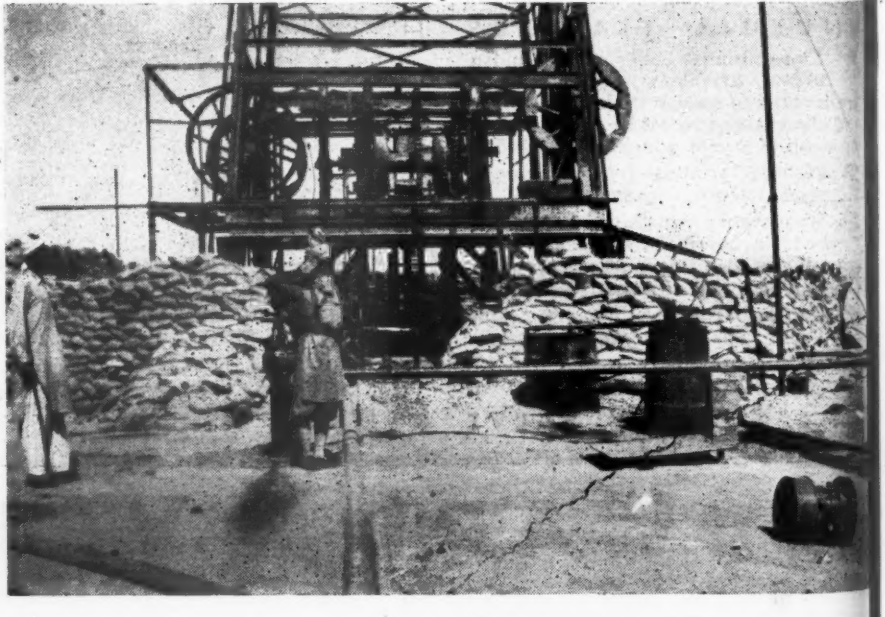
Unlike in the Khaur field, the developed high pressure drilling technique could not be applied to the wells in the Dhulian field because the various water-bearing strata would take fluid at an approximate average of 400 lb. per sq. in. Successful completions were eventually obtained by the expedient of frequent, often constant, changing of drilling mud, a close check on the weight of which was maintained at all times, the free flow of water being permitted. Polluted returns from the well were reconditioned at a centrally located pug mill and mud plant. After passing through a high-volume water zone, casing would be set and cemented with sufficient cement to shut off the water at bottom but to allow it to flow freely up behind the casing and through the two outlets on the landing flange. From here it was piped away from the well and allowed to flow unrestricted. In this manner water pressures were systematically reduced and eventually rendered practically nil.

A floating unpredictable producing zone varying as much as 1200 ft. in depth between locations and at times not even picked up at all, was repeatedly tested with minor results after showing plenty of life while drilling. The hard limestone marker for the objective deeper zone was comparatively uniform in thickness although its location might vary 100 ft. or so in depth. This formation was penetrated for a specified distance and 7-in. flush joint casing was then set and cemented top to bottom. While the cement was setting, high pressure drilling and production installations were made. After drilling out the cement the lime would be penetrated a given distance; the drilling mud would then be changed to oil and drilling continued.

When the producing zone was picked up the well would automatically start producing. Because that eventuality had been foreseen and provided for, everything was very much in order. The part of the zone penetrated would be permitted to produce at a reasonable maximum capacity for an hour or less, but long enough to determine the dependable initial production capacity of the well. The decision on whether or not to penetrate further would then have to be made. The well's potential possibilities in view of market requirements and refining and storage facilities would have to be taken into consideration as well as the possibility of picking up bottom water. When the desired objective had been attained the drill pipe would be pulled a safe distance up into the casing and a production test made to establish dependability, this test lasting overnight.

If satisfactory results were obtained it would be desirable to remove the drill pipe. The snubbing methods, such as re-

One of the producing wells protected with sand bags, Dhulian field.



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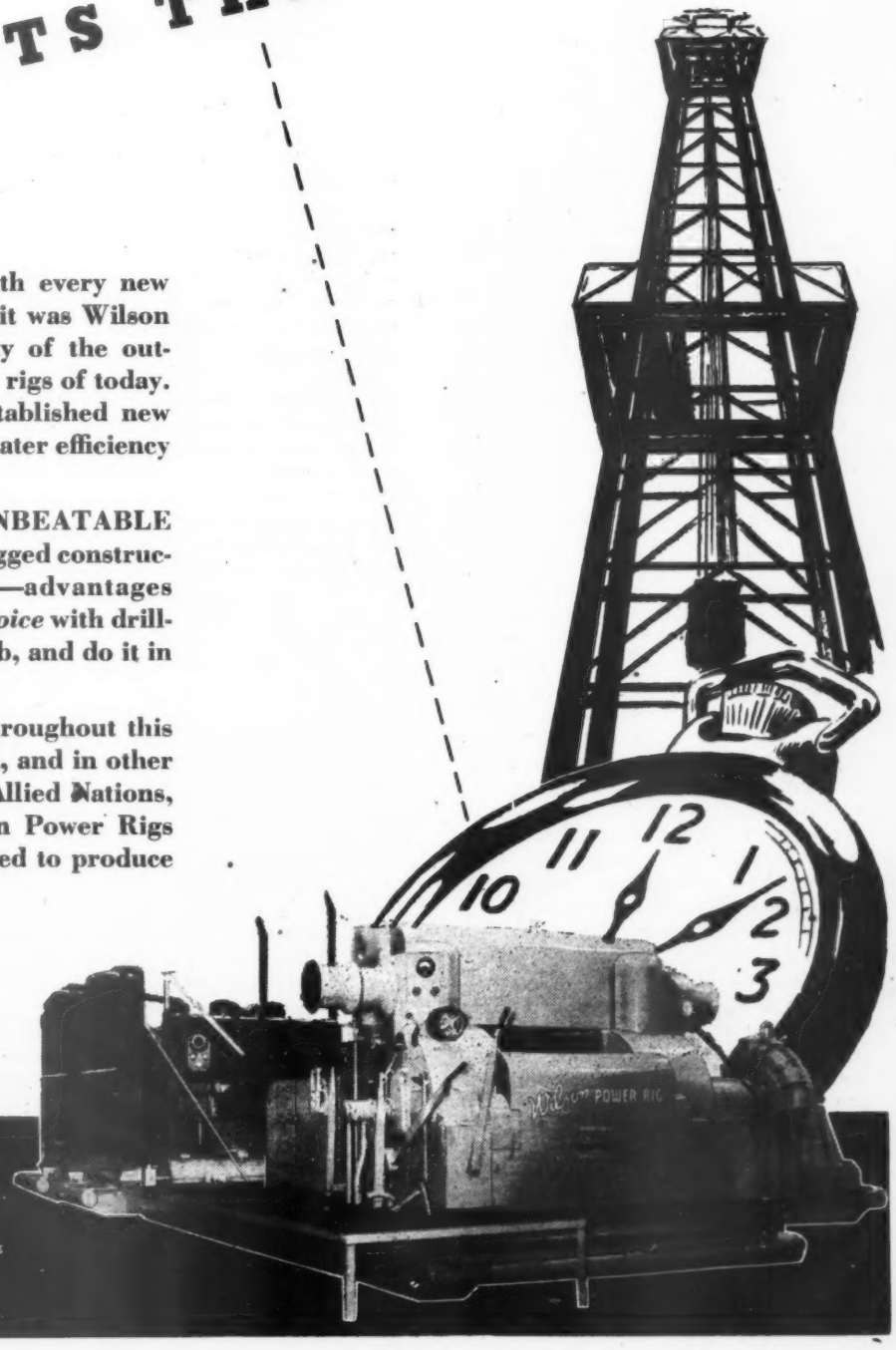

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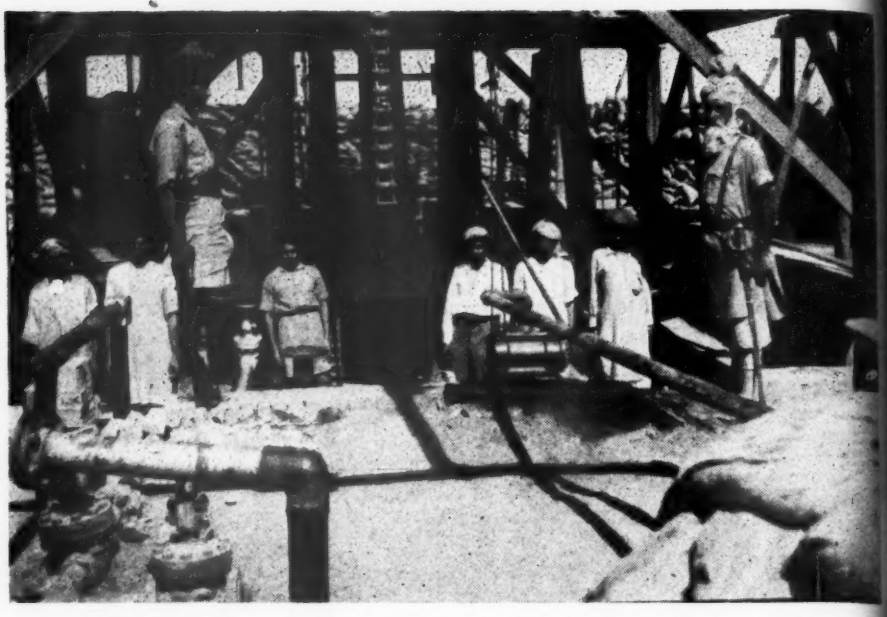
quired in the field at Khaur in drilling through the high pressure water zone, was not used. At Khaur high pressure had to be maintained at the top of the hole at all times to avoid loss of hole, sticking the drill pipe or casing, and similar hazards. This added pressure was supplied from outside sources, or to be more precise, by the multiple compounding of sufficient pumps to match the hydrostatic pressure as generated by the water-bearing strata, plus an added margin for sufficient safety factor. The latter was usually 200 to 300 lb. per sq. in. for a total top-hole pressure of approximately 2500 lb. per sq. in.

The technique found to be effective for pulling the drill pipe from the production pressure wells in the Dhulian field was as follows: The wells would be permitted to flow at a desired pressure rate through the outlets on the cross between the two 8-in. master valves, then through an adjustable-bean manifold at the derrick floor for accessability. From there the production would go through a series of gas traps into gauging or production tanks. The drill pipe would be started out of the hole in the usual conventional manner, except for chain-tonging instead of rotating out, to preserve as much as possible the packer-blowout preventer and standby head. The latter could be of the hydrostatic type actuated by hydraulic ram.

It should be mentioned here that before starting to pull, sufficient water was pumped in through the kelly to fill the drill pipe about one-third of the way down. The high gas pressure in the hole kept closed the dual back pressure valves located just above the bit. The reason for applying the water is obvious. As the entire string of drill pipe had to be pulled wet anyhow and water being much cleaner and less slippery than oil, it did aid appreciably in the ease and speed with which the drill pipe could be pulled. Whenever the wet job became oily the kelly was again connected and an additional measured amount of water was pumped in.

When the drill pipe had been pulled up to a point where the weight indicator suggested that to venture further might have proved hazardous, pulling was halted long enough to bleed off some of the pressure through the adjustable bean manifold, routing it through the two 6-in. flare lines and lighting them at the outlet ends. Most, if not all, of this oil could have been run into production tanks but for lack of sufficient storage facilities.

When the pressure had been lowered to the point of guaranteeing safety, pulling operations were resumed. As the load became lighter and lighter the pressure would be further reduced gradually, most often periodically, and so timed that when there remained only a few stands left to pull, the well would be flowing wide open through the flare lines. It was allowed to flow in that manner until the remainder of the drill pipe had been pulled. As soon as the bit or core barrel had been pulled up into the chamber above the top master valve, this valve would be closed and the well beaned down appreciably.



Indian workmen and their guards at a producing well.

The next step was to check the top master valve for leaks due to improper or incomplete closing. This was done through the outlets of the cross used for return circulation while drilling; it was at top of the chamber and just below the high pressure packoff heads. If found to be gas tight the well was then put on permanent production and, over a period of several days, would be gradually beaned down to the desired production and pressure point.

In the meantime drilling heads, connections, and other equipment would be removed and the Christmas tree and other permanent connections installed. All installations were pre-assembled as far as possible, being made up tightly by cathead, using an aluminum-like self-hardening compound on the joints. Due to the fact that these installations might have been required to hold pressures twice as great as, or greater than, the working-pressure rating of what was then the highest pressure fittings available, all assemblies were thoroughly tested at maximum pressures before being entrusted with production control of the well.

Cellars were approximately 35 ft. deep, circular in shape and about 12 ft. in diameter; the walls were built either of bricks or of concrete. On one side was a runway extending some distance from the well and sloping from the cellar level to ground level. This runway was wide enough to allow for the installation of extended outside controls for the two 3-in. controlled valves that were on each side. These valves were on lines that issued horizontally from the 8-in. cross between the two 8-in. master valves. The lines on which the valves were installed extended vertically to connect directly to the lines projecting from the top 8-in. cross and the versatile hookup beyond. The control extensions were of reliable pipe, with universal joints between each joint of each control to compensate for the rise between cellar level and ground level at end of runway.

From this point the master and control valves were operated manually. To keep the cellar dry, a pump capable of running submerged, if necessary, was installed at the cellar end of the runway. Incidentally, the cellar and runway formation was hard. They were dug by hand, by contracted Indian labor, mostly Pathans. The cuttings, or diggings, were carried off by a string of small, though active burros.

A problem of considerable interest was the "killing" of one of these high pressure wells. The first well brought in, No. 7, barely scratched the pay formation and was producing approximately 700 bbl. per day with high gas pressure. The killing of the well was decided upon because of leaky and otherwise unsatisfactory production connections in the cellar. The well had, moreover, been producing for several months with the drill pipe still in the hole.

The drill pipe was pulled to break off the bit. After being run it was pulled again while additional boilers were installed to overcome the lack of sufficient steam to operate all four pumps compounded. A mud weighted to 165 lb. per cu. ft. and otherwise treated was then pumped in. As soon as satisfactory returns were obtained and the well looked as though it might be content to lie dormant for a while, the drill pipe was removed. As soon as possible all cellar connections were taken off and adequate installations made. Because there was more production from the field than required, it was decided to leave the well closed in. After a few days a gauge was put on to check the pressure condition of the well. It was found that pressure had built up to about 2000 lb. per sq. in. In bleeding that off slowly the well produced only dry gas. It was again closed in and in a day or so built up to 1000 lb. per sq. in. The well was again bled off and the procedure of allowing it to build up a pressure of 1000 lb. per sq. in. and then bleeding it off was followed.

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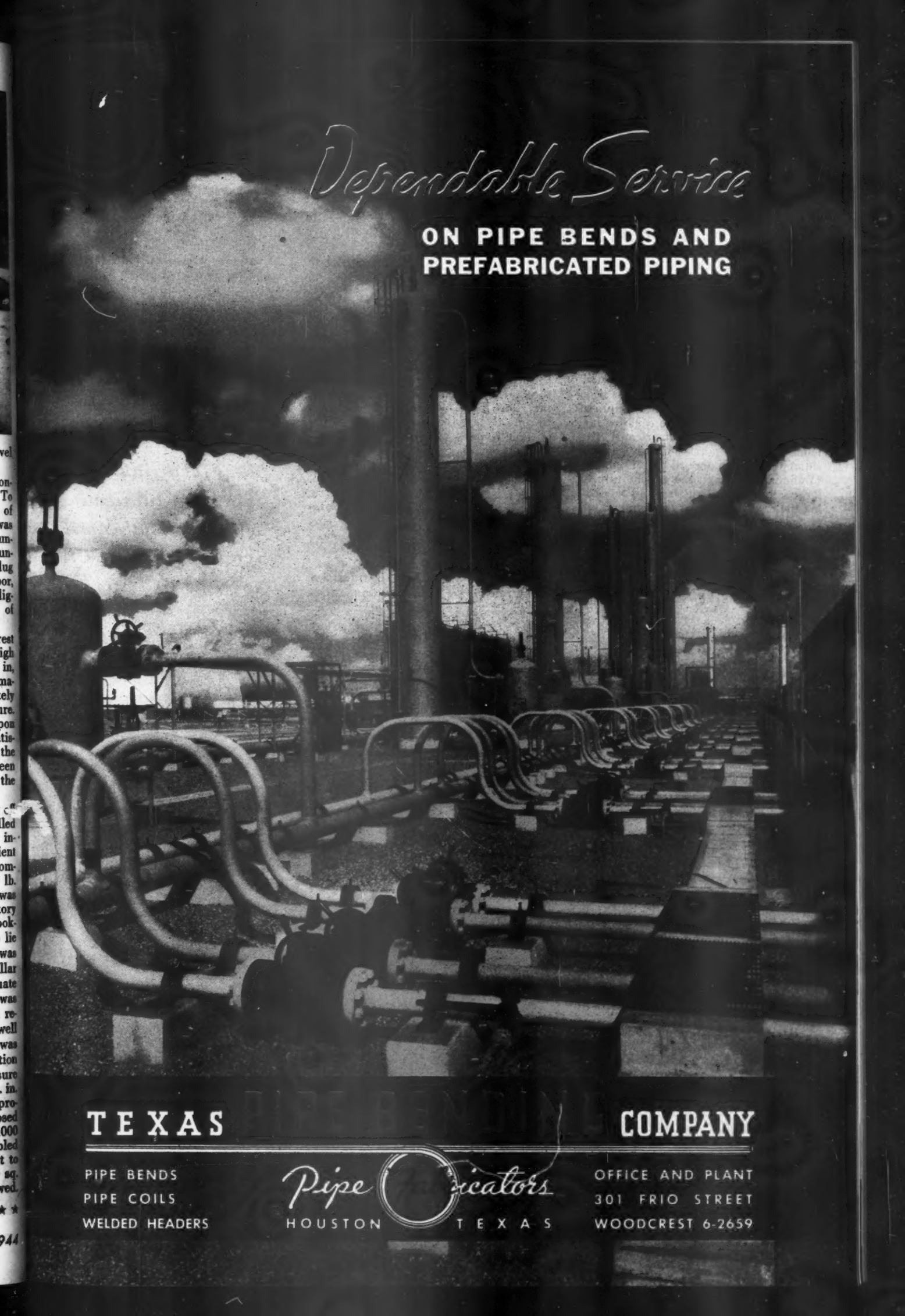
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ARUBA REFINERY A SOURCE OF MANY PETROLEUM PRODUCTS

By **W. W. DAMM,** Standard Oil Company (N. J.)

Foreign Refining Department

Manufacturing everything but lubricating oils, this South American plant helps to speed Allied victory.

EXCLUSIVE TWENTY years ago the island of Aruba, then little known to North Americans, was selected as the site of a petroleum refinery. Originally planned and built as a two-product refinery for the production of gasoline and fuel oil, it has been greatly expanded since it was acquired by the Standard Oil Company (New Jersey) in 1932 from Pan American Petroleum and Transport Company, a subsidiary of the Standard Oil Company (Indiana). Through the expenditure of large sums in modernizing and increasing the capacity, the Aruba refinery, operated by the Lago Oil and Transport Company, with a capacity of nearly 300,000 bbl. per day just prior to the United States' entry into the war, became generally regarded as the largest refinery in the world.

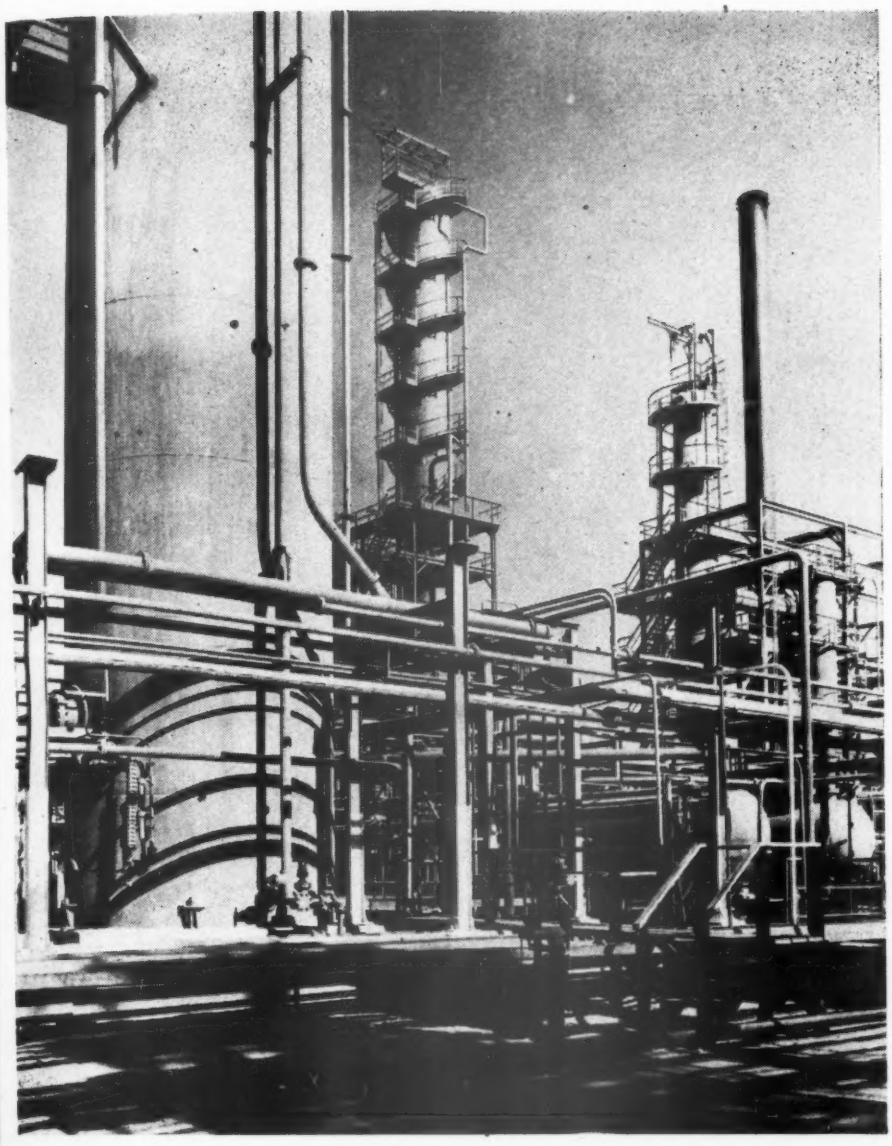
Aruba and the adjacent island of Curacao, with deep water ports close to a large potential petroleum production, were logical locations for refineries. In prewar days these refineries were important sources of petroleum products for European countries, and also served as bunkering ports for trans-Atlantic and coastal vessels.

All oil for Aruba's refinery is transported by boat. Crude from Lake Maracaibo, which constitutes the major portion, is brought from Venezuela in shallow draft tankers of 30,000-bbl. capacity and from other ports in ocean tankers. Finished products in turn are transported by tankers to their final destination. To insure adequate facilities for storing the oil and the products between their arrival and shipment, there are at the refinery some 200 tanks with an aggregate capacity of 13,500,000 bbl.

Until the outbreak of the war Aruba's petroleum products went principally to British and European markets. The war blockade cut off the Axis powers from the oil, and their share then became available to the British and other friendly nations. War greatly stimulated demand for petroleum by the belligerents; at first mostly to fuel ships of war and ships carrying supplies across the Atlantic, and later also to fuel the growing air fleets and all the land equipment: Tanks, trucks, jeeps, and the like, employed in motorized warfare.

Expanded before the war, the Aruba refinery was designed to manufacture all major petroleum products with the ex-

General view of Aruba refinery showing naphtha re-run units at left; cracking units in distance.



Alkylation plant of Lago refinery on Aruba, off Venezuela coast.

ception of lubricating oils. It manufactured kerosine, diesel fuels, distillate and residual fuel oils, and asphalt. Unfinished base stocks for lubricating oils were exported for final processing. As the refinery is relatively new, much of the equipment is very modern. The refinery contains crude stills, thermal cracking units, an Edeleanu plant for upgrading kerosine fractions, an acid-treating plant, a sweetening plant, etc., as well as power houses and an extensive tank farm.

The Aruba refinery was also equipped some time before the war with polymerization facilities for the preparation of codimer and with a hydrogenation plant for the hydrogenation of codimer to hydrocodimer aviation gasoline blending agent. Alkylation, a process for producing isooctane by the interaction of butylenes with isobutane, which became commercially feasible in 1938, offered an ideal method of making 100-octane aviation gasoline blending agent, and, by 1939 Aruba had added an alkylation plant to its facilities. Thus, when war demands for 100-octane aviation gasoline arose, Aruba was in a position to supply the gasoline. This 100-octane aviation gasoline consisted of a high octane straight run gasoline from selected crudes blended with an approximately equal amount of either hydrocodimer or alkylate and tetraethyl lead.

By 1941, with a continuing demand for more and more 100-octane aviation gasoline, it became desirable to increase both Aruba's blending agent capacity and the capacity for the production of high octane gasoline base stock. For this purpose it was decided to erect a catalytic cracking unit and to expand alkylation facilities. Moreover, to obtain sufficient quantities of isobutane to supply the alkylation plant, an isomerization plant was also installed.

The cracking process selected was the fluid catalyst cracking process developed by the Standard Oil Company (N.J.) associated companies. To build such a unit meant transporting to Aruba some $10,000,000 worth of equipment. In the course of delivering the equipment, more cargo was unloaded at Aruba in less time than ever before in the refinery's history.

Erecting the unit presented difficult engineering problems. An excavation 17 ft. below sea level at the edge of the lagoon had to be pumped continuously to keep out water that flooded into it. Water was pumped out at the rate of 40,000 gal. per min. to permit pouring the concrete, and at the completion of the job the pumps were worn to the point of having to be discarded. Eventually the 250-ft. high fluid catalyst cracking unit was completed, and, by supplying catalytically cracked base stock for the aviatiton gasoline together with feed stock for the alkylate unit, it more than trebled the production of 100-octane aviation gasoline. The cracking unit was formally dedicated on December 5, 1943, and operated uninterruptedly for the next six months, at which time the run was terminated for routine inspection of the unit. Since then it has resumed operation, contributing its share to the immense quantities of 100-octane aviation gasoline demanded by the Allied air fleets.

The catalytic cracking unit is the most spectacular piece of equipment recently added to the refinery. Aviation gasoline is not by any means the only product of the refinery important to the prosecution of the war. Diesel power is becoming of ever greater importance as evidenced by the fact that the U. S. Navy alone now reports having 33,000,000 hp. of diesel engines. A large percentage of the diesel fuel used in the war is produced at Aruba. Still more important from the standpoint of volume is the fuel oil needed to power the steam turbines of the large ships of the Allied navies and merchant fleets. A single destroyer consumes 1700 bbl. of fuel in 24 hr. and a transport or aircraft carrier nearly four times as much. Fuel oil must be produced in huge quantities for naval vessels and merchant ships, and Aruba's oil fuels ships around the world. The petroleum product produced in greater quantities than any single other petroleum product is, of couse, motor gasoline, and Aruba does much to supply the Allied countries with both civilian motor gasoline and the 80-octane all purpose gasoline to run mechanized military vehicles.

War has brought expansion and refinement to an already modern petroleum refinery at Aruba. The wartime changes have been carried out with unprecedented rapidity and have operated with exceptional efficiency. Erecting new equipment in wartime has not been an easy matter. Nearly 200,000 gal. per day of drinking water for the island must be imported from the United States, and additional amounts of fresh water in much greater quantities for refinery use must be provided by distillation of sea water. During the period of much of the wartime construction work total blackout prevailed throughout the island. Moreover, being a military base, movements in certain areas are restricted. The approximately 6500 employees of the refinery have also suffered the rationing and shortages experienced in other critical war zones. But results have proved the efforts worthwhile, as Aruba enjoys the satisfaction of playing a major role in supplying petroleum products to speed the day of victory for the Allies.

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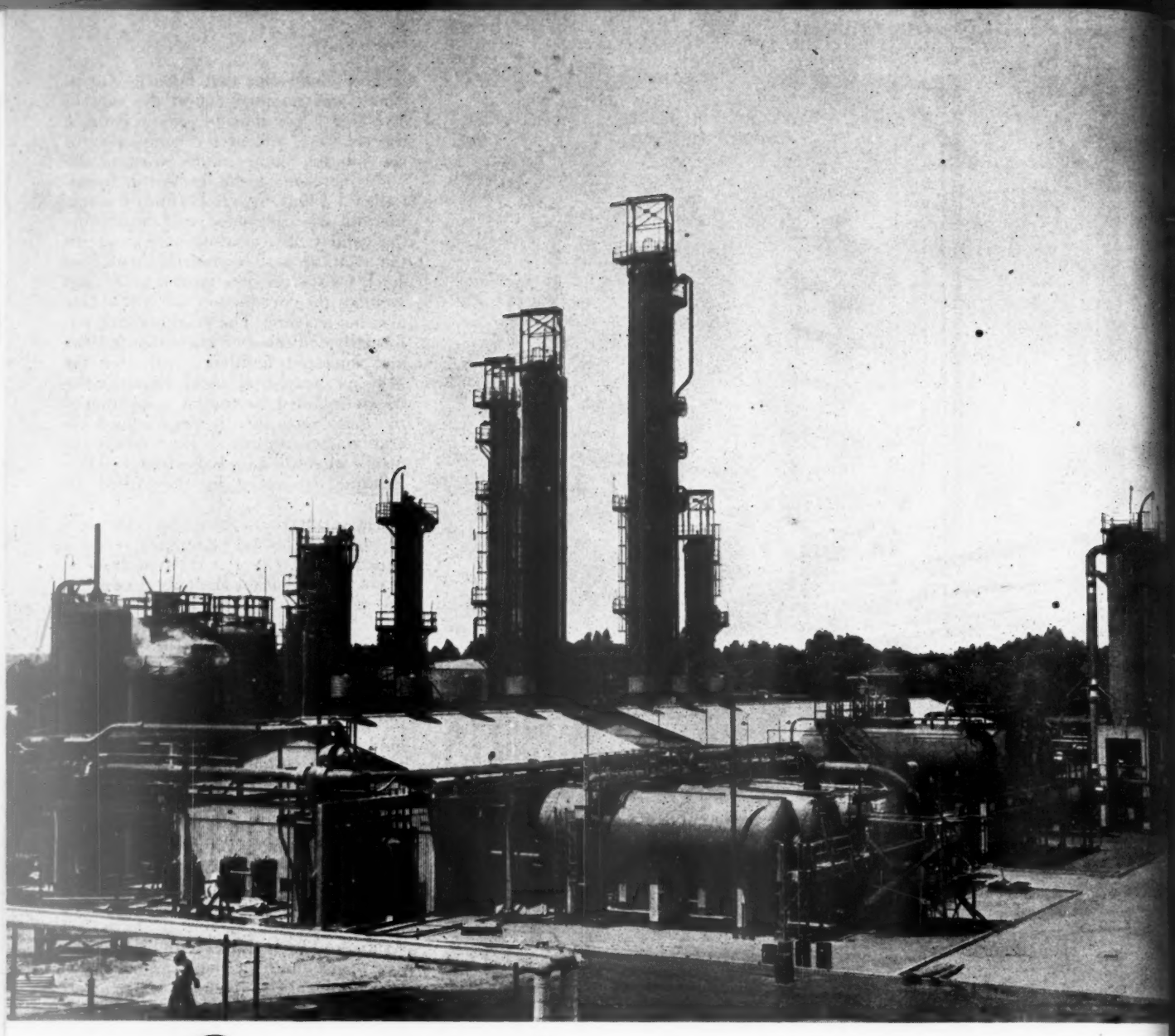

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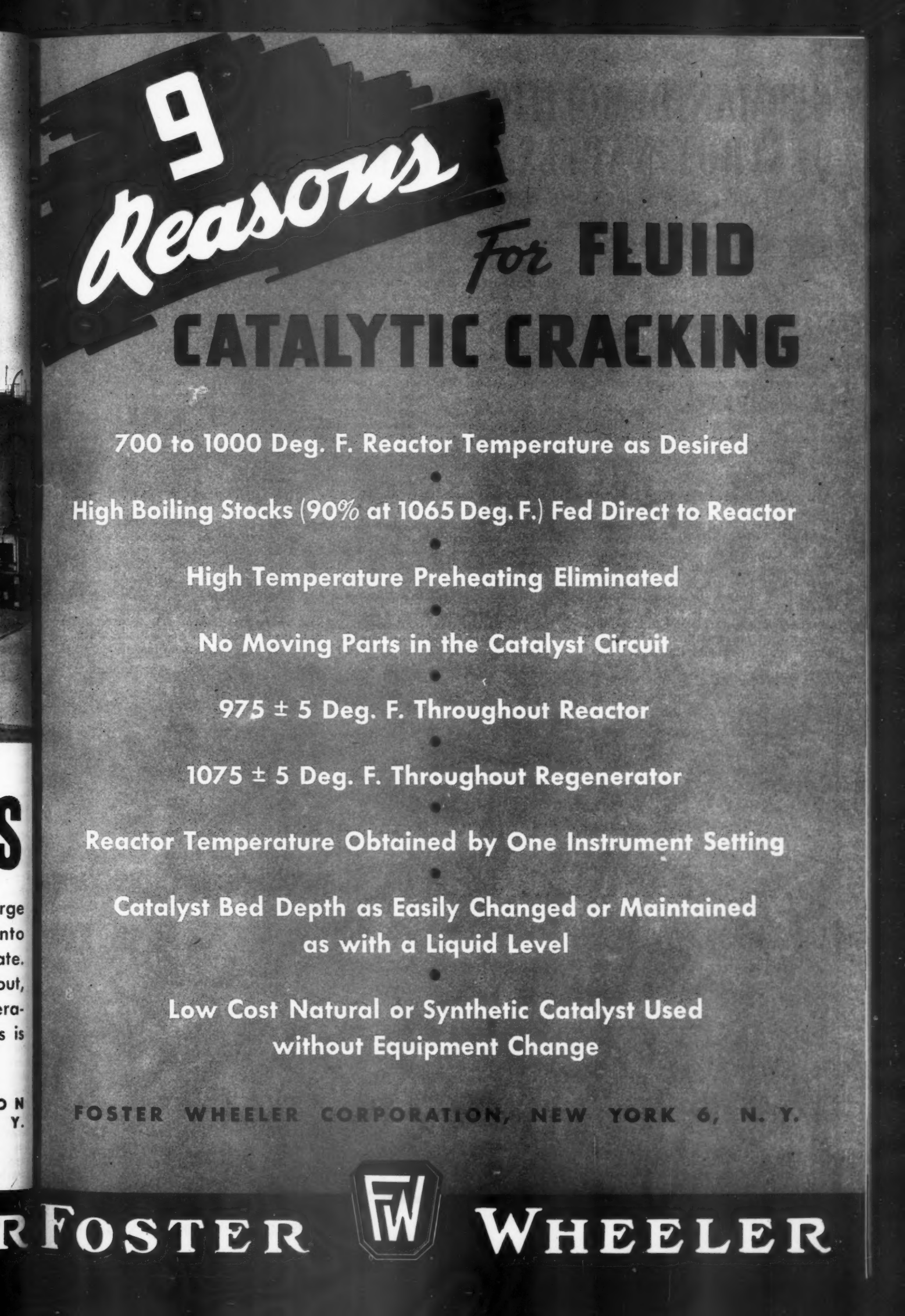
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GERMAN DEMOLITION SQUADS DESTROY NAPLES REFINERY

By **JOHN H. KUNKEL,** *Refinery Editor*

EXCLUSIVE WHEN Naples was freed from Axis domination by the victorious arms of the United Nations, Raffineria di Napoli, S.A.I., the Socony-Vacuum Oil Company, Inc., refinery in that Italian city became the first of the enemy-held American refineries to become available for inspection. Its total and complete destruction by German demolition squads, in a 4-day orgy conducted just before the Germans evacuated Naples, constitutes a preview of what American petroleum companies may expect to find when other American-owned refineries in Europe and Asia are freed.

Raffineria di Napoli was built by Socony-Vacuum in 1937 on a tract of land approximately 60 acres in area situated at the outskirts of Naples. Prior to 1941, its crude oil was received principally from the Gulf Coast by tanker and the refinery's throughput was about 6000 bbl. per day. Although it did not rank among the large refineries of the world, nevertheless in design, equipment, and processes it was one of the most modern. Historically—and of subsequent strategic importance to the high-octane hungry Germany Luftwaffe—this refinery contained the first Houdry catalytic cracking plant to be built in Europe. This plant, which incidentally was the third Houdry plant to be placed on stream anywhere, was a 3-case unit with a capacity of 2600 bbl. per day. The refinery also contained a 4100 bbl. per day Badger 2-stage pipestill distillation unit, asphalt oxidizing stills and blending tanks, a gasoline and light oil finishing plant, a Duo-Sol plant, a lube oil refining plant, a solvent dewaxing plant, an acid treating unit, a contact neutralizing and clay decolorizing unit, and a lube compounding and packaging unit. Storage facilities consisted of eight 12,800 metric ton capacity crude storage tanks and more than 100 intermediate and finished product storage tanks of varying capacities. Other structures included a cooling tower, administration buildings, cafeteria and recreation center, mechanical shops, chemical laboratory, power plant, fire department buildings, storehouse, and railroad sidings.

Raffineria di Napoli was sequestered in December, 1941, by AGIP, an Italian state-owned petroleum corporation and, because of the infiltration of the German army into Italy, the refinery fell, as well, under German domination.

Although the refinery was American owned, it had been sequestered by an enemy nation at war with the United States. In enemy hands, and under enemy operation, it was a source of fuel and petroleum products for the German Luftwaffe, the Italian air force, the Italian navy, the motorized units of both enemy armies, and its products lubricated the wheels of enemy war plants. With its production thus turned against the United Nations, it became a legitimate target for air attack.

▼ **Air raid protection.** When viewed by an American representative of Socony-Vacuum, there was little evidence that the Italians or the Germans had done much to protect the refinery and its units against damage from aerial bombardment. Storage tanks had not been staved nor were they surrounded by concrete walls. There was no evidence that columns, vessels, or other refinery equipment had been protected by any means. The extent of air raid protection consisted of the construction of a number of concrete air raid shelters, earthen dykes thrown up along both sides of the railroad siding, and a network of trenches dug through the refinery area presumably for the protection of refinery or military personnel.

The first taste of war occurred before the refinery was sequestered when, on July 11, 1941, a munitions train, spotted

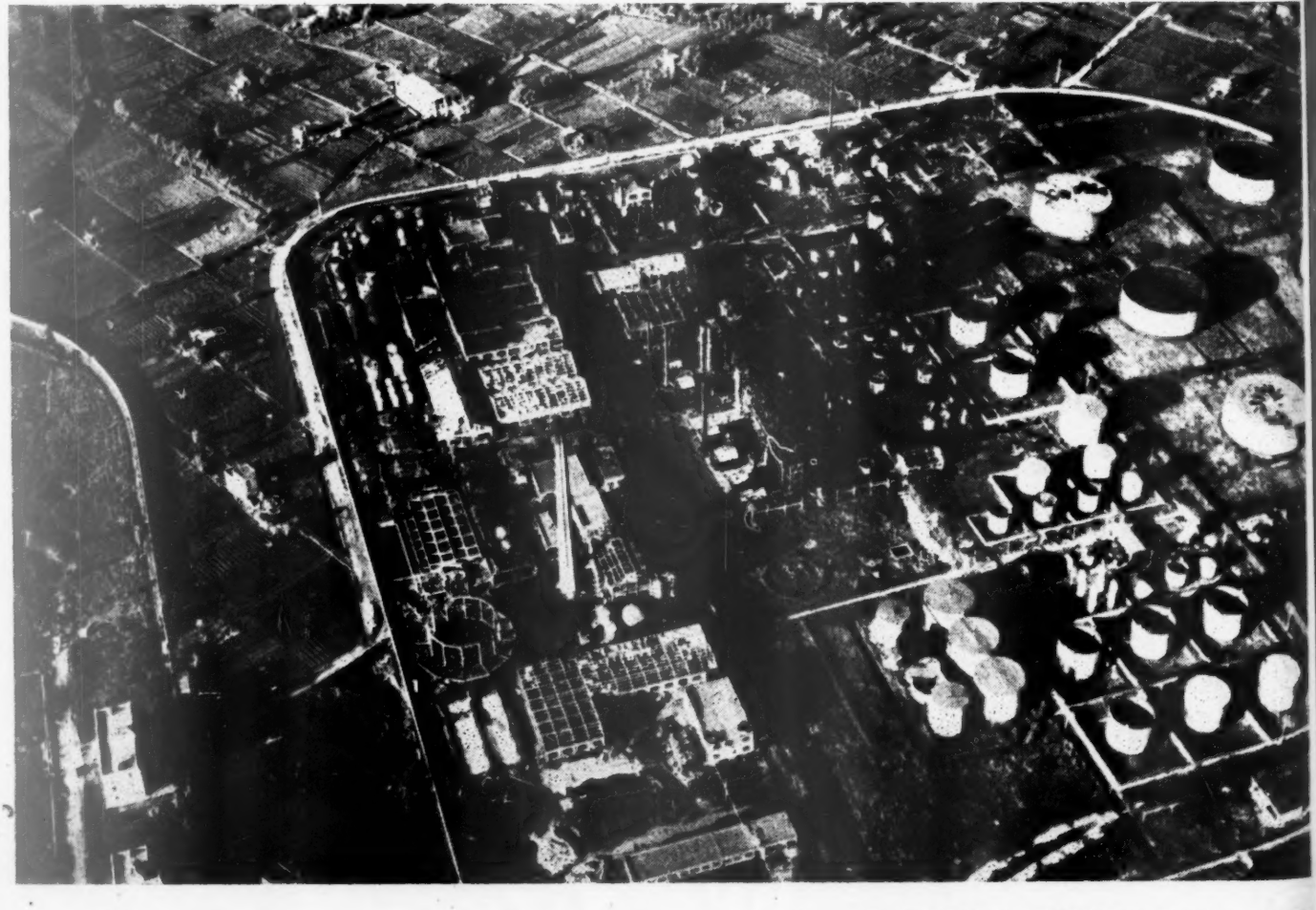
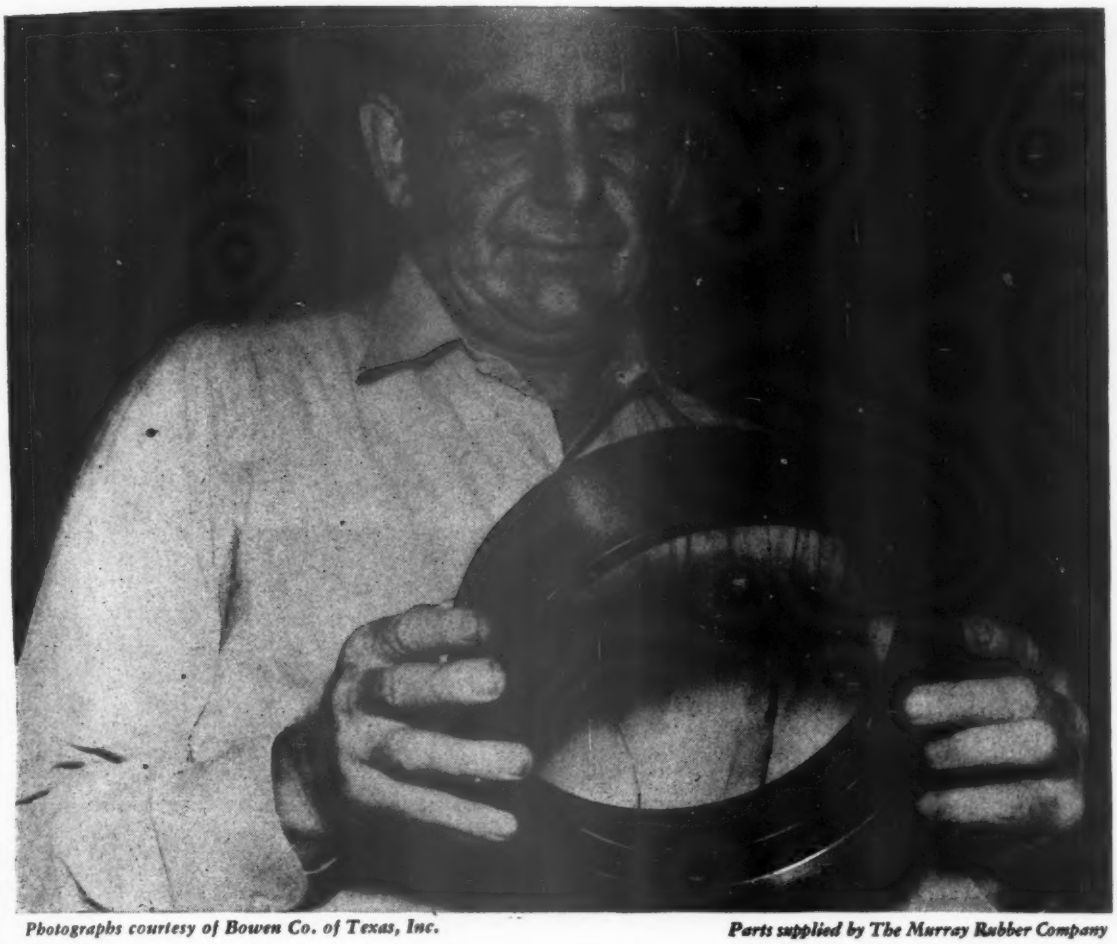
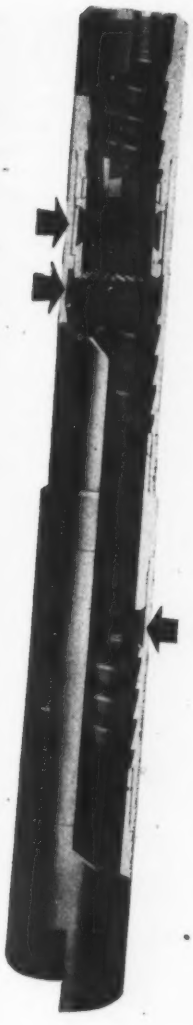


Fig. 1. A bird's-eye view of Raffineria di Napoli after its destruction by German demolition squads. ***(Press Association, Inc., Photo.)***



Photographs courtesy of Bowen Co. of Texas, Inc.



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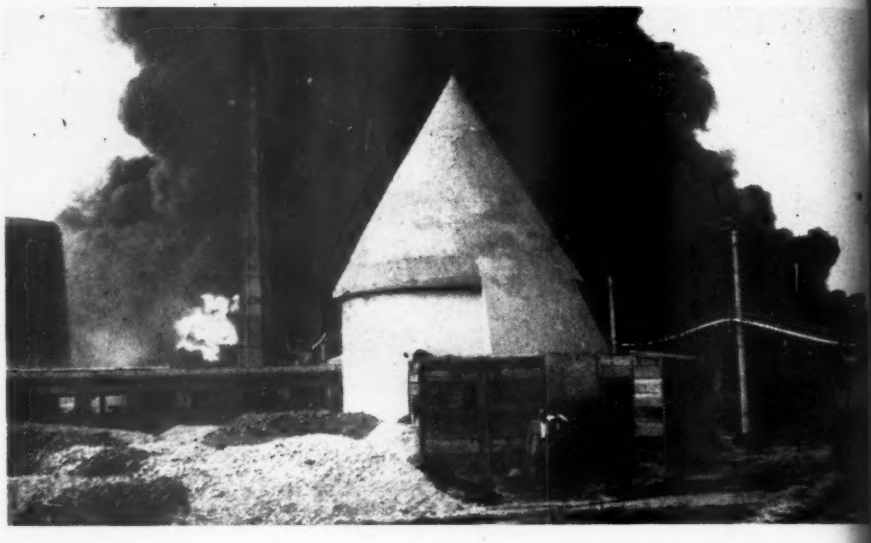
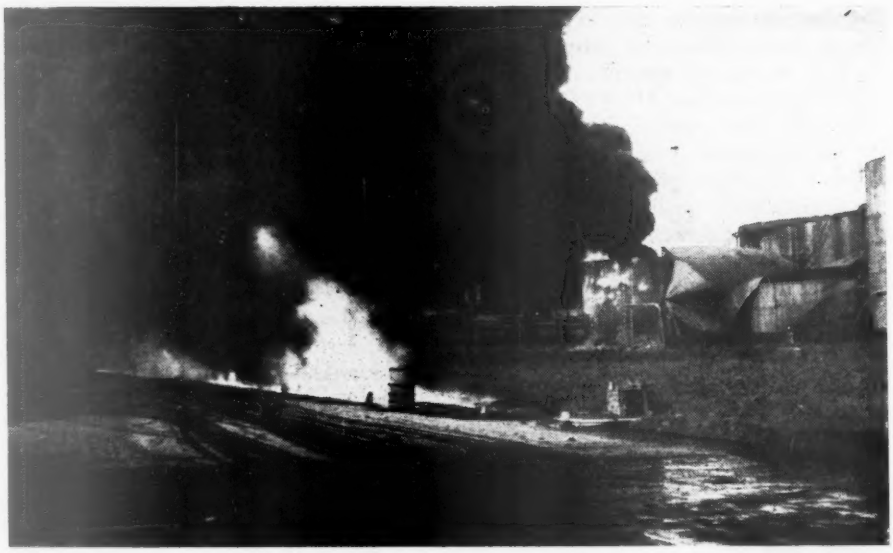
on a railroad siding blew up. The damage from this explosion, however, was minor and was largely confined to broken window panes and damaged roofs. The first aerial bombardment occurred in January, 1943, and these raids continued intermittently through July with the first substantial damage inflicted during a raid in April. A heavy bombardment took place with the raid of July 15 and the largest raid occurred 2 days later, on July 17, when 9 successive waves of bombers swept over the refinery.

So important are the products of petroleum to the nations engaged in World War II that any production of end products, in any quantities, in any refinery, large or small, on stream or likely to be reconstructed to go on stream anywhere in the world is a matter vital to both sides. To one side, the preservation of refineries and their maintenance on-stream is essential so that the engines of war may be fueled and the wheels of war plants be kept turning. To the other side, the destruction of such refineries to the extent of knocking and keeping them off stream is a military necessity. There was, however, no justification for the total destruction of Raffineria di Napoli to the point where the entire refinery was leveled by the German demolition squads prior to their evacuation.

There was little chance that the United Nations, or Italy, would place the refinery back on stream during the war. To do so, shipping bottoms badly needed



***Top*—View of Raffineria di Napoli taken during construction in 1937. *Right*—Refinery put to the torch. Note air raid shelter. *Below*—Ruins of storage tanks.**



for the larger production of finished products from the United States would have been required to transport crude and, beyond that, critical materials and man-hours would have been necessary to build refinery equipment required.

Immediately after Naples was occupied by the armed forces of the United Nations, an American representative of Socony-Vacuum visited Raffineria di Napoli to survey the extent of the damage. The sight that greeted him is illustrated by Fig. 1, an aerial view of the refinery after its destruction by the German demolition squads. The bare, almost open space in the center of the refinery area shows what remained of the distillation unit and the 3-case Houdry catalytic cracking plant. The shambles that were the Duo-Sol plant, the contact neutralizing unit, refined oil finishing plant, and the dewaxing unit are in the upper center. In the upper left-hand corner can be seen the remnants of the lube oil and compounding units. The circular framed object in the center along the left-hand border is wh was the cooling tower. In this area al are the remains of the power house, t mechanical shops, chemical laboratory and garage. Crude oil storage, interme diate product and finished product stor age tanks are shown at the right.

What could be destroyed by fire wa put to the torch while demolition bomb were used to blast buildings, vessel fractionating columns, tanks, exchang ers, coolers, etc. The control room, al instruments, all electrical equipment an automatic valve controls were blasted The refinery's 3 furnaces and its steam superheater were seriously damaged All pumps, 2 pump houses, and the re finery's 2 gas compressors were wrecke and smashed by bombs. In short, the en tire refinery and all its units were vi tually leveled and to place it back o stream it would have to be rebuilt in i entirety. According to D. L. Hooker manager of Socony-Vacuum's foreig and eastern refineries, plans for its re building are indefinite.

Other Socony-Vacuum refineries i Germany or in German occupied cou tries include 2 in Germany, 1 in Ol Austria, 1 in Hungary, 1 in Yugoslavi 1 in Poland, 1 in Romania, 1 in Czech slovakia, and 2 in France. Nearly eve one of these plants has gone through th front line and it is to be hoped that the will be spared the wanton treatment a corded Raffineria di Napoli. ★ ★

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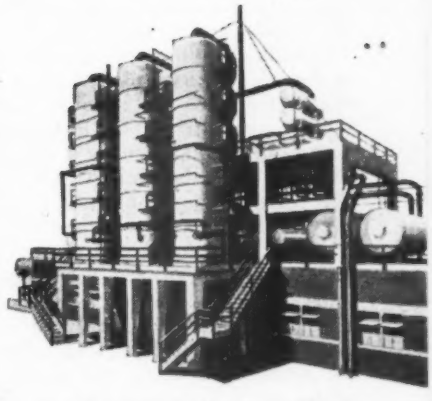

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CANADIAN OIL SITUATION

By FLOYD K. BEACH*

EXCLUSIVE THIS article was prepared for *The Petroleum Engineer's* "foreign" number. Many Americans who read this may consider Canada a foreign country, though from what we can observe, the American oil men who come up here rather get over that idea once they are well past the customs house at the border. As for Canadians, most of them look on the United States as being scarcely different from their own country. The radio and American movies and American magazines help to induce this attitude, and then there is Canada's place in the British Empire. We can't help feeling that the attitude toward the United States to be found in many Canadian minds arises not in spite of, but because of, the Canadian position in the Empire. We are proud that Canada is an independent nation, and we are proud of our allegiance to the Crown, but we put up a customs tariff against British imports just the same. So, although we are of the Empire, we are separate. Britain is not a foreign country nor is it exactly identical with our own. The bonds between Canada and Britain are those of mutual respect and interdependence, and not of compulsion. The bonds of mutual respect and interdependence between Canada and the United States are only less strong than those that bind us to the Empire. The only danger that we can foresee to continued pleasant relations is lack of knowledge about and understanding of each other. Canada sees and hears much of America, but America doesn't hear so much about us. We hope this article may be informative.

Canada is quite dependent at present on American oil supplies, and at a time when Americans are rationing gasoline to their own citizens, we in Canada are most grateful that continued supplies of oil come from the United States. If we were writing about pulp and paper and many other commodities, the shoe would be on the other foot.

For some years the search for new oil fields in western Canada has had American participation. During the current season two major American companies are active in drilling and most of the others are represented here by various numbers of geologists, geophysicists, and other technicians. Some have limited their investigations to brief scouting trips but others have put a number of parties in the field, and the areas to be covered this season are remarkably widespread, extending (though of course not continuously) from the Montana border north pretty well to the Arctic.

With so much American money being spent in Canada it is to be expected that the organizations supplying the funds have their ears to the ground for the significance of political events in this country. In August of this year Alberta held an election. Four parties were campaigning, but the real issue raised was between the Social Credit Party in power and the CCF (Cooperative Commonwealth Federation), a socialist organization. The CCF openly advocated socialization of oil and diversion of oil profits to the public purse. The government in power took the stand that the oil industry has to take risks that would be out of place for a government to undertake. The government was returned to power by an overwhelming majority, CCF obtaining only 2 seats and others 4 out of a 57 member house. This sweeping victory for the government in power can be credited in a large degree to its policy on the oil industry, for it is conceded that many voters who disagreed with their theories on fiscal matters supported them through fear of CCF threats. It would appear that American capital may look for stability in oil legislation for the present. With so secure a majority it is not likely there will be another Alberta election for 5 years.

Hon. N. E. Tanner, Minister of Lands and Mines for Alberta, whose oil development policy wins at polls.

▼ **Leasing conditions in western Canada.** It is worth while reminding American readers that tenure of oil rights in western Canada is quite different from most parts of the United States. As the Crown reserved mineral rights when granting homesteads and otherwise disposing of the surface, the problem of obtaining petroleum and natural gas rights is simplified to dealing with a government agency in each province. There are exceptions in case of the Hudsons Bay Company, which received a grant of 5 per cent of the land and minerals, and in the cases of railway land grants, but at that the leasing problem is fairly simple as contrasted with the usual American problem of hunting down individual owners.

In the Western Provinces and in Northwest Territories and Yukon, regulations and provincial acts provide in general for dealing with those who wish to make broad geological and geophysical studies by issue of permits or reservations covering quite an area for a relatively short time. There are also provisions for leasing smaller areas over longer periods. The following very abbreviated summary is intended only to give a general picture and for detailed information prospective lessees should communicate with the authorities mentioned. Fees are not listed in all cases. They are in general additional to rentals.

▼ **Saskatchewan.** Leasing handled by Supervisor of Mines, Department of Natural Resources, Regina.

Permits to prospect may be taken out by paying a fee and rental of 10 cents per acre for a year with option of a 6-month extension, and by providing a bond to spend 40 cents per acre in drilling. Subsurface information must be supplied the government.

Leases: 50 cents per acre the first year, $1.00 subsequently. Tenure 21 years and renewable for 21 years more.

Area in a lease: 40 to 1920 acres in unsurveyed territory or up to 19,200 acres in surveyed territory.

Obligation to drill: Starting within 15 months on at least one of a group of leases, the aggregate area of which does not exceed 19,200 acres.

Royalty: On natural gas, subject to current order in council, with minimum 5 per cent of sale price.

On oil, subject to current order in council but not less than 2½ per cent nor more than 5 per cent for first 5 years following discovery; 5 to 10 per cent for second 5 years; 10 per cent thereafter.

Informative discussion gives details of petroleum industry, including drilling and production data, refining facilities, and laws governing operations.

▼ **Alberta.** Dispositions handled by Superintendent, Mining Lands Division, Department of Lands and Mines, Edmonton, Alberta. Agencies also at Calgary and Peace River.

Reservations may be issued covering 10,000 to 200,000 acres for 60 days for a fee of $250 and a cash deposit of $750 if only geological work is contemplated or deposit of $2000 if geophysical work is to be done. This deposit required for each 20,000 acres in the reservation. The deposit is returned on submission of geological and other reports and proof of expenditure as great as the deposit. Extensions are made by 60-day periods up to a year on much the same basis with provisions to protect both parties, but there is no extra fee.

Reservations up to 10,000 acres may

*Floyd K. Beach is a Major, Royal Canadian Engineers (Reserve of Officers), and a member of the Engineering Institute of Canada, a professional engineer (Alberta), and a Dominion land surveyor. He went to the Canadian West in 1906 and except for three years in the Canadian Expeditionary Force in the last war has remained there. Since 1927 has served with the Dominion and Alberta governments and the Petroleum and Natural Gas Conservation Board in administration of oil and gas laws; now with the latter as engineer in charge of oil and gas production records.

be taken for examination by drilling. Fee of $250 and deposit of $1 an acre, refundable on proof of expenditures in drilling satisfactory to the Minister, are required.

Leases: $1 per acre yearly. Tenure 21 years and renewable for another 21 years.

Area in a lease: 160 to 1920 acres.

Drilling obligation: To start within one year at least one well in a group comprising 30 square miles and situated within 25 miles; to continue drillings to the satisfaction of the Minister and to offset producing wells on adjacent lands.

Credits: Applicable in lieu of rental may be established by drilling and other accepted expenditure but not if a well is within ⅝ mile of a producing oil or gas well.

Royalty on oil: Except for some old leases, choice of flat 12½ per cent royalty or sliding scale, square root of average daily production in each month with limits until 1951 of 15 per cent maximum and 5 per cent minimum. On gas, 15 per cent of sale with minimum of ¼ cent per M. cu. ft.

Miscellaneous: Certain areas have been set aside as Crown Reserves. Special rules apply here.

▼ **British Columbia.** Leasing by The Minister of Lands, Victoria, B. C.

Permits covering up to 256,000 acres may be taken for a fee and rental of 5 cents per acre for one year. Rental is returnable on submission of geological and other reports and proof of expenditure in that amount, or if person selects an area and takes out a license.

License covers 2 square miles.

Drilling obligations: To start within 6 months and continue to completion. Rental 50 cents per acre yearly, which may be rebated on proof of spending $7.50 per acre on drilling. Licenses may be grouped and one well drilled on group.

Leases cover same area as a license. Rental is $1 per acre yearly. License is to be converted to lease on discovery of oil, and an equal area, equally well chosen on structure to be selected as Crown Reserve.

Royalty: 12½ per cent on oil. It has been brought to our attention that in the United States where a company pays 12½ per cent royalty to a land owner, it is considered on the average that the land owner is an equal beneficiary in profits from oil production with the company doing development. It is pointed out also that rentals are only paid to land owners in lieu of immediate drilling. Where, as in British Columbia, the land owner requires in addition to continued rentals and 12½ per cent royalty a full half share in any fields discovered, there is little incentive for development.

It is worthy of note that the British Columbia regulations are quite recent, and that the only drilling in the Peace River block of British Columbia is a well, now abandoned, that was drilled by provincial funds. It will be of interest to see whether any private capital will be attracted by the terms offered.

▼ **Northwest Territories and Yukon.** Leasing, etc., is by Director of Lands, Parks and Forests, Department of Mines and Resources, Ottawa, Ont.

Permits to prospect may cover 64,000 to 256,000 acres. To run for 3 years with renewal for 3 years and provision for successive decrease in size. Fee and bond to spend 20 cents per acre in first 18 months, 40 cents per acre in second 18 months, $1 per acre in second 3 years. Bonds posted from time to time and released as reports of findings and proof of expenditure come in.

Leases may be selected covering 2 to 4 square miles; rental 50 cents per acre for first year, $1 per acre thereafter.

Royalty: 7½ per cent for first 5 years after discovery, 10 per cent for second 5 years, 12½ per cent afterward. Provision for reducing royalty if operations border on uneconomic.

Land is unsurveyed and permits, etc., must be marked on the ground and surveyed.

It would appear that the Dominion government may, in making agreements with permittees, retain ownership in some portion of the oil recovered. In case of Canol, it appears that the Canadian government retains a one-third share in the proved field and pays its one-third share of actual direct cost of producing oil plus a management fee of 10 per cent.

▼ **Eastern Canada.** Although there is no oil production in Quebec or Nova Scotia, and only small production in New Brunswick, it is understood that the provincial governments control most of the rights to minerals, and have made regulations governing disposal of the rights and rates of royalty. Interested parties may obtain further information from the respective provincial governments.

▼ **Alberta Petroleum Association.** This voluntary association of oil producers has found itself charged as an organization with correlating the requirements for drilling equipment, automotive equipment for the industry; gasoline for such vehicles, labor requirements, etc., and acts as intermediary in obtaining the necessary priorities, ration allowances, and deferments in army call up. The president, B. L. Thorne, M.E.I.C., died in March and Fred M. Graham was elected to take his place, with F. F. Reeve as vice president. E. W. Kolb continues as secretary, with offices in the Lancaster Building, Calgary.

▼ **Oil publications.** C. O. Nickle publishes a daily and a weekly mimeographed sheet on oil and is a very accurate reporter. Lancaster Building, Calgary, is his address. *Western Oil Examiner* publishes a weekly 4-page printed paper, issued in Calgary.

The Dominion Geological Survey at Ottawa has made extensive geological surveys and maps have been printed for distribution at a small price covering much of western Canada.

Dr. G. S. Hume prepared a most valuable booklet issued this year by Dominion Geological Survey, entitled "Petroleum Geology of Canada." In 64 pages, he covers a broad field, but gives much detail respecting each area of interest.

The Petroleum and Natural Gas Conservation Board, Calgary, puts out a weekly summary giving approximate average daily oil production, and details of drilling in Turner Valley, with some brief data on wildcat activity. They also publish a monthly mimeographed report covering oil development and production of oil and gas, with quite detailed figures for Turner Valley. A mimeographed book gave tabulated production figures for all Turner Valley wells by months to the end of 1940, and a subsequent printed volume to the end of 1942 gives summaries by years of all oil and gas production in Alberta together with monthly figures for 1941 and 1942. Many other data on oil development are also contained therein. These publications are issued on a basis intended only to cover cost: $1.50 for 1940 book and $3 for 1941

Safety trophies awarded

Petroleum companies were awarded trophies for achievements in safety by the National Safety Council in Chicago on October 6 to: Pan American Petroleum and Transport Refinery, Everett, Massachusetts; Stanolind Oil and Gas Company, Tulsa, Oklahoma; Union Oil Company of California; Gulf Companies, Houston, Texas; Globe Oil and Refining Company, Wichita, Kansas; Continental Oil Company, Ponca City, Oklahoma; Atlantic Pipe Line Company, Dallas, Texas; Standard Oil Company of Indiana, Chicago, Illinois; Arkansas Fuel Oil Company, Shreveport, Louisiana; and Humble Oil and Refining Company, Houston, Texas.

Winners awarded certificates were: Standard Oil Company of Louisiana, Baton Rouge, Louisiana; Continental Oil Company, Ponca City, Oklahoma; Shell Oil Company, Inc., New York; Humble Oil & Refining Company, Houston, Texas; Atlantic Refining Company, Dallas, Texas; Mid-Continent Petroleum Corporation, Tulsa, Oklahoma; Gulf Oil Corporation, Gulf Production Division; Sinclair Refining Company, New York; Wood River Oil and Refining Company, Inc., Hartford, Illinois; Humble Oil and Refining Company, Houston, Texas; Ohio Oil Company, Findlay, Ohio; Stanolind Pipe Line Company, Tulsa, Oklahoma; Socony-Vacuum Oil Company, Inc., New York; Gulf Oil Corporation, Houston, Texas; Gulf Refining Company, Gulf Production Division; Socony-Vacuum Oil Company and Union Oil Company of California.

book. The Department of Lands and Mines also has published a "Schedule of Wells Drilled for Oil and Gas in Alberta to 1941," obtainable from the Superintendent of Mining Lands, Edmonton, at a cost of $2.

The Conservation Board also has a lithograph map of Turner Valley showing well locations at about 3000 ft. to an inch, obtainable for 25 cents, and a map of southern Alberta Plains, 4 miles to the inch covering townships 1 to 22 between 4th and 5th Meridians showing well locations. Ozalid prints at cost of printing and postage are $1.75 each.

▼ **Income tax.** Canadian income tax was at one itme collected both by the Dominion government and by provinces as well. Early in the war the Dominion made arrangements with the provinces whereby this tax would be collected only by the Dominion.

With respect to persons, the tax is at a much higher rate than anything in the States, but so far as we can observe, the effect on cost of living is no greater, for the Dominion has held down the price of many scarce commodities and the burden of war costs has thus been well distributed.

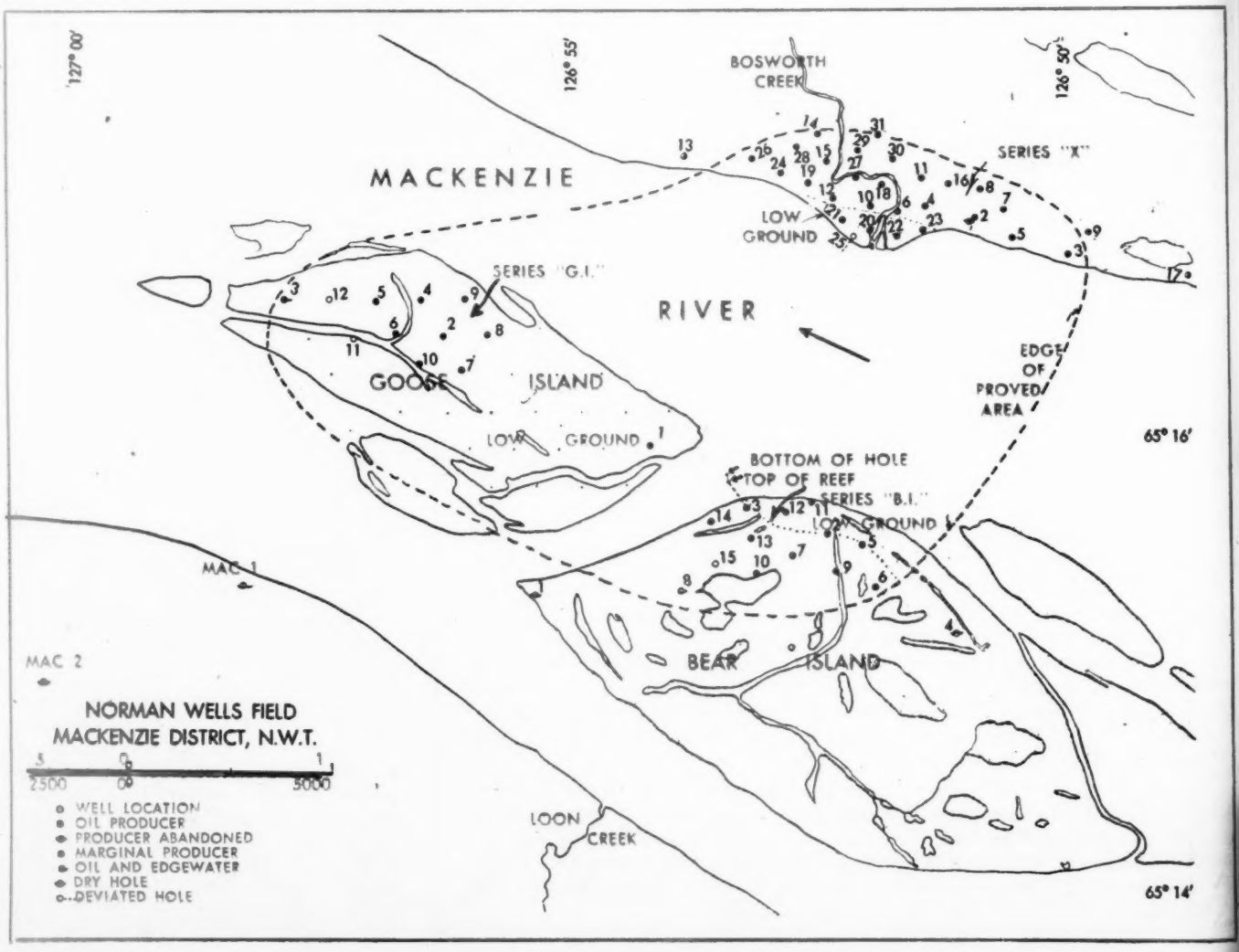
With respect to corporations, the income tax did have a tendency to discourage new ventures, but recently a new ruling makes it possible for companies who make profits from handling oil to deduct from the income tax otherwise payable, 50 per cent of expenditures including geological and geophysical expenditures in connection with drilling of deep test oil wells begun between June 26, 1944, and the end of March, 1945. The close of the period is that of the close of the fiscal year and it is assumed that future policy in this line will be governed by future developments.

Previous concessions have followed a somewhat different line in providing for amortization of capital cost of investments in wells that prove to be oil producers. The whole subject is rather too complicated to cover in the small space available here, but interested parties may obtain full information from the Department of Finance at Ottawa.

▼ **Canol.** The pipe line from Norman Wells field to Whitehorse and refinery at Whitehorse were reported in operation on April 30. This project received much publicity during the Truman Committee hearing but it might be in order to recall that when the project was authorized by the United States War Department, shipping losses had been heavy and tankers scarce. The United States fleet had suffered staggering losses at Pearl Harbor, the British had lost Hongkong and the loss of Singapore was imminent. Japanese submarines were operating off the coast of North America and there was fear that even if tankers were available they might not be able to supply Alaska adequately with oil. Alaska was on the route of supply to Russia and the need both for aviation gasoline and for fuel for naval vessels in that theater was urgent. Under these conditions, interior communications were essential.

Hon. T. A. Crerar, minister of Mines and Resources in the Dominion Cabinet, who looked after Canadian participation in the Canol project.

At the time authority was granted there were two wells that had produced oil over a period of years, and two more that had been drilled recently. The two oldest wells had been completed in shale and the fact that they produced up to 125 bbl. a day suggested that the production came from crevices and that a true reservoir had not been tapped. They were only 150 ft. apart. The third well, 2750 ft. up river from the discovery well was so small as to make it of doubtful value, although it has since been reworked and made into a fair producer. A fourth well about 1200 ft. down river



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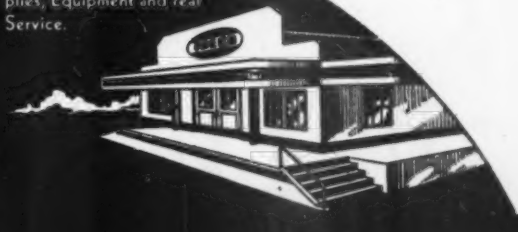

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from the discovery was better and would produce 150 bbl. a day. Wells drilled on Bear Island opposite the discovery, at "C" camp on the left bank a couple of miles up river from Loon Creek, and several at greater distances away, were all dry holes although most of them went deeper than the discovery well.

In the face of this accumulation of rather discouraging data, pipe for the line to Whitehorse was shipped north at the same time as crews and rigs to drill enough wells to fill the pipe line. Since then the record of successful wells drilled is remarkably good and the record to the end of August stands as follows:

Right Bank (Series X). Producing 27, marginal 2, abandoned 1 (this is the discovery well).

Bear Island (Series B.I). Producing 12, marginal 1, dry hole 1.

Goose Island (Series G.I.). Producing 10.

The total number of wells at the end of August was: Producing 49, marginal 3, dry holes 1, producer abandoned 1.

It is now known that the field covers about 4260 acres, of which about 650 acres are on high, safe ground, 940 acres on relatively low ground subject to flood conditions, and 2670 acres under the Mackenzie River. Of this submerged portion it is believed that something less than 56 per cent could be drained by directional drilling.

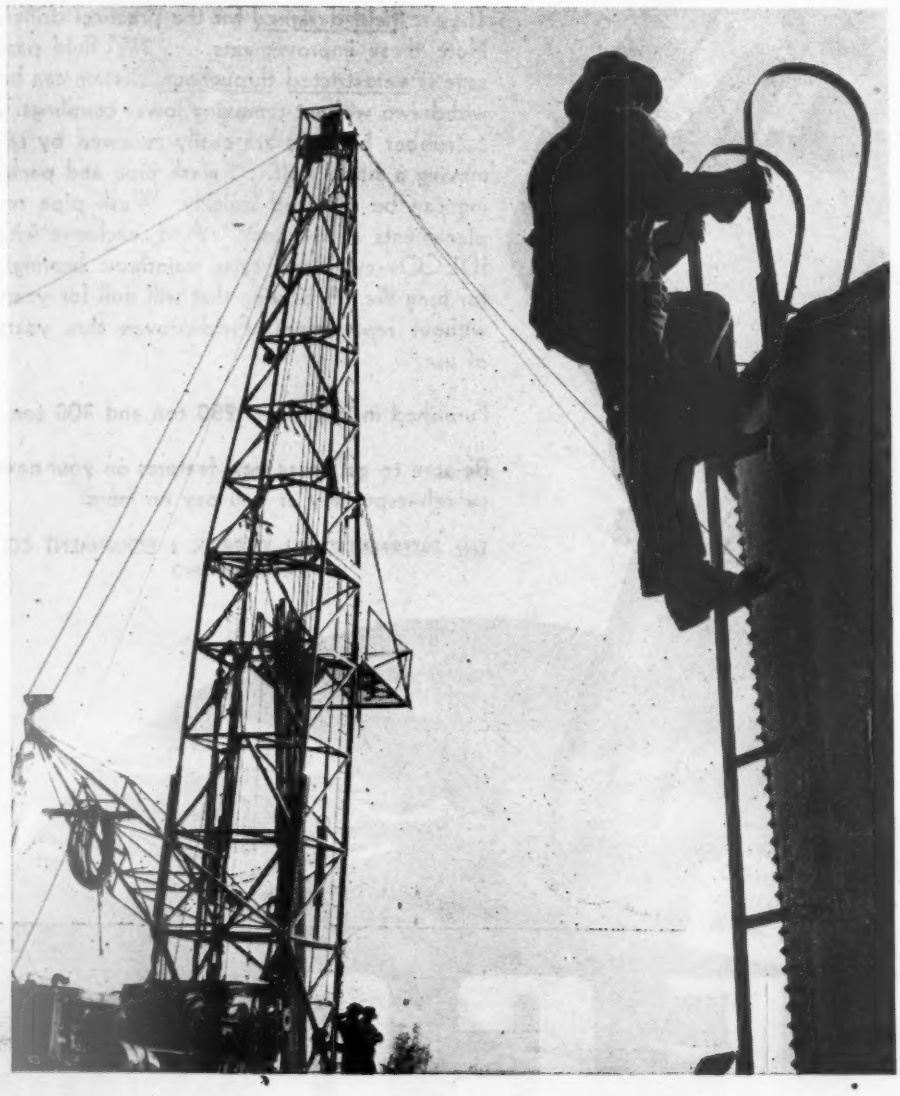
Bear Island No. 3 is a successfully deviated hole. The outline of the field has been fairly well established by drilling. Edgewater has appeared in the lower sections of the reef limestone penetrated by wells on the down dip side of Bear and Goose islands.

Average depth of Right Bank wells is 1470 ft., Bear Island wells 2082 ft., and Goose Island wells 2034 ft.

Original production in the Discovery No. 1 well was obtained from the Upper Fort Creek shales through fractures in the shale. Additional drilling proved the important source of oil to be a coral reef limestone of Upper Devonian age. The coral reef limestone upper porous zone varies in thickness from 0 to approximately 350-400 ft. (this is a local coral reef development). This section overlies approximately 100 ft. of barren impermeable limestones of widespread occurrence. In the area of the proved field the reef limestone series is separated from the underlying Beavertail limestone by the lower Fort Creek shale, which varies from approximately 385 to 540 ft. in thickness. The structure is monoclinal and dips about 4° to the S.W. Closure is due to the pinching out of the reef on the up dip side.

A derrick in operation at Norman Wells. Scores of wells such as this will feed oil to Pacific war machines through 500 miles of pipe line. Joe Russell, drilling boss, who comes from the Turner Valley oil field, is shown climbing ladder on the storage tank at the right.

—Photo by National Film Board.



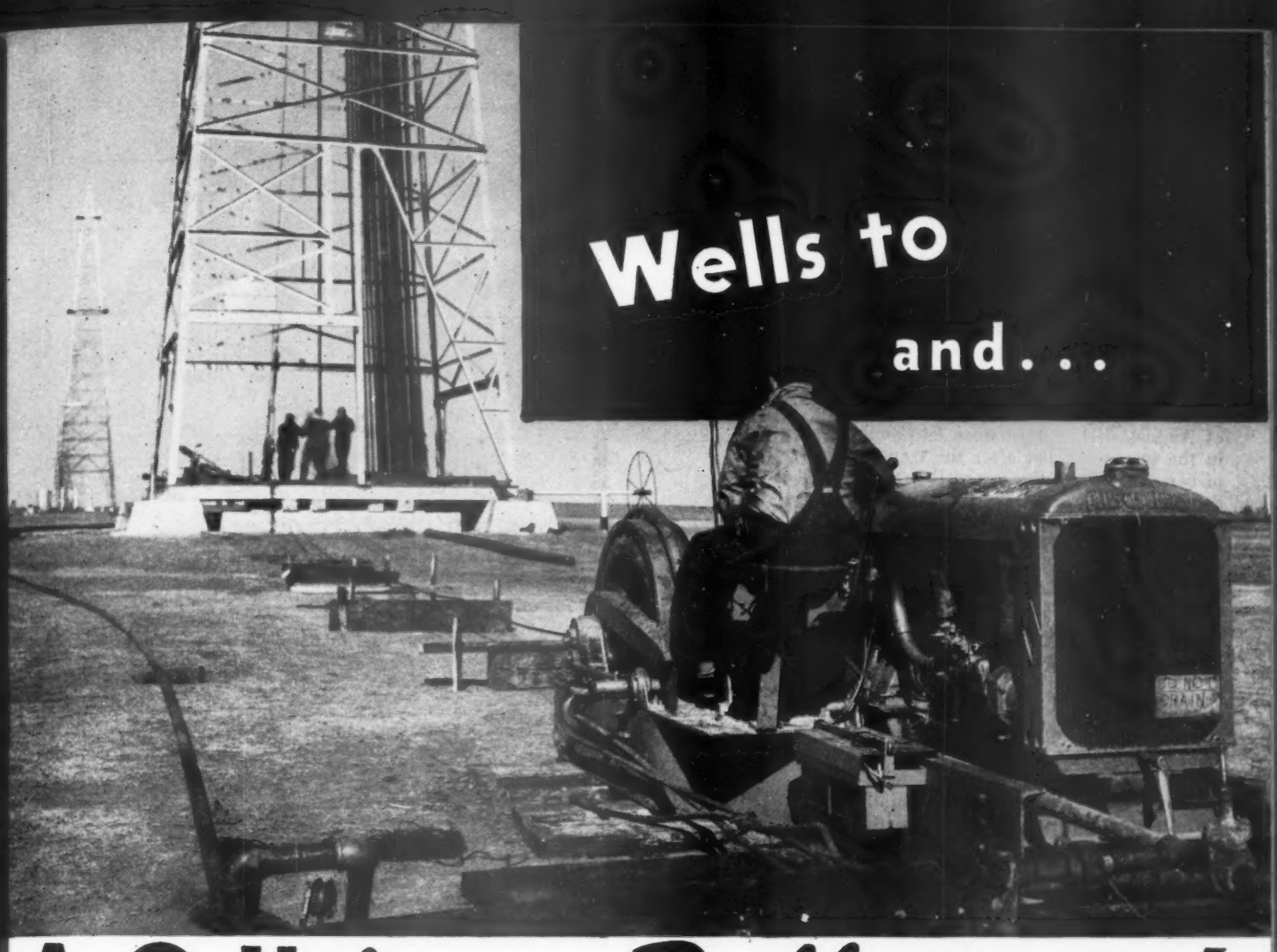
Log of typical right bank well		Log of typical Bear Island well
Elevation, 329 ft.		Elevation, 300 ft.
0— 70 ft.	Surface sand	0— 240 ft.
none	Cretaceous	240— 430 ft.
70— 220 ft.	Bosworth sandstones	430— 880 ft.
220— 955 ft.	Upper Fort Creek shales	880—1595 ft.
955—1120 ft.	Bituminous zone	1595—1725 ft.
1120—1485 ft.	Reef limestone	1725—2056 ft.
1485—1522 ft.	Lower Fort Creek shales	
1522 ft.	Total depth	2056 ft.

The oil has a gravity of about 38° API and a remarkably low pourpoint. It is obtained by natural flow with a gas-oil ratio (July average) of about 590 cu. ft. per bbl. Production from the field is governed by pipe line facilities and local demand. A small straight distillation plant installed in 1938 produces aviation gasoline and other products for local needs. The Dominion Bureau of Statistics reports production from Northwest Territories in June of 111,124 bbl., with total for 6 months this year of 569,784 bbl. As this field is the only one in Northwest Territories, it may be assumed this covers only Norman Wells field.

A release by the Wartime Information Board in May gave an estimate of oil reserves in the field as 30 to 60 million barrels, and remarked that actual size of the field can only be determined as additional wells are drilled and it is found how much of the oil underlying the Mackenzie River can be recovered.

In mentioning the fact that quite a portion of the land area overlying the field is low ground subject to flood conditions we might remind those unfamiliar with the country that rivers flowing northward in this latitude are subject to ice jams in the spring. More southerly tributaries break up, often with quite a freshet, when the ice is still solid farther north, and the enhanced flow is likely to break up ice that is still very solid.

P. W. Lambright is manager of the Canol Project for Imperial Oil, Ltd., who are under contract to deliver oil to the United States War Department. Some further exploration was undertaken and Imperial acquired permits covering about 140,000 acres; however, as the strategic situation changed the United States government decided against enlarging the pipe line and wildcatting has been discontinued. Only those operations considered necessary to maintain the present pipe line at full capacity are being continued. It was estimated that a large enough pipe line to make continued commercial operation feasible would cost about $60,000,000 and that a reserve of at least 300,000,000 bbl. would be needed to warrant the expenditure. Owing to the remote location—some 1100 miles by air and nearly 1500 miles by land and water from Edmonton—the natural outlet is by way of the present pipe line route and use of the oil in Canada would in-



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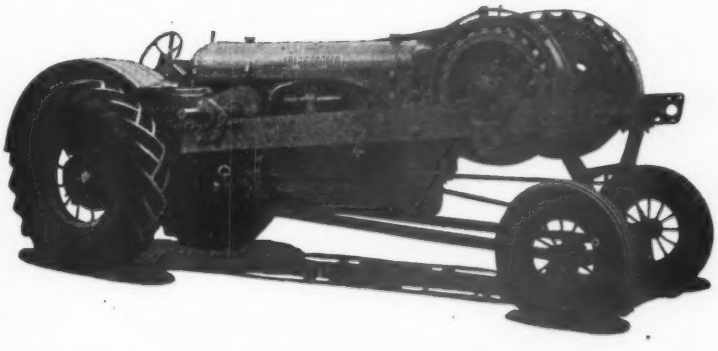
As long as oil wells have to be pulled, Allis-Chalmers Skid Winches and Winch Tractors will be available to keep them producing. *This is the well servicing equipment that many producers depend on exclusively.*



ALLIS-CHALMERS Model E WINCH TRACTOR . . . One of the seven sizes of single and double drum Winch Tractors.

The Model E has a maximum line pull of 58,970 ft. lbs. Available in single or double drum type. Eight line speeds on the winch drum to 1,074' p.m. at 1,200 engine r.p.m. Engine develops a torque of 400 ft. lbs. Fuel: Butane, natural gas, gasoline, or distillate.

Allis-Chalmers equipment has been called upon to maintain a large percent of the "wells on pump" in this country. Their manufacture for the oil industry has never ceased —and now they are being delivered in increasing number.

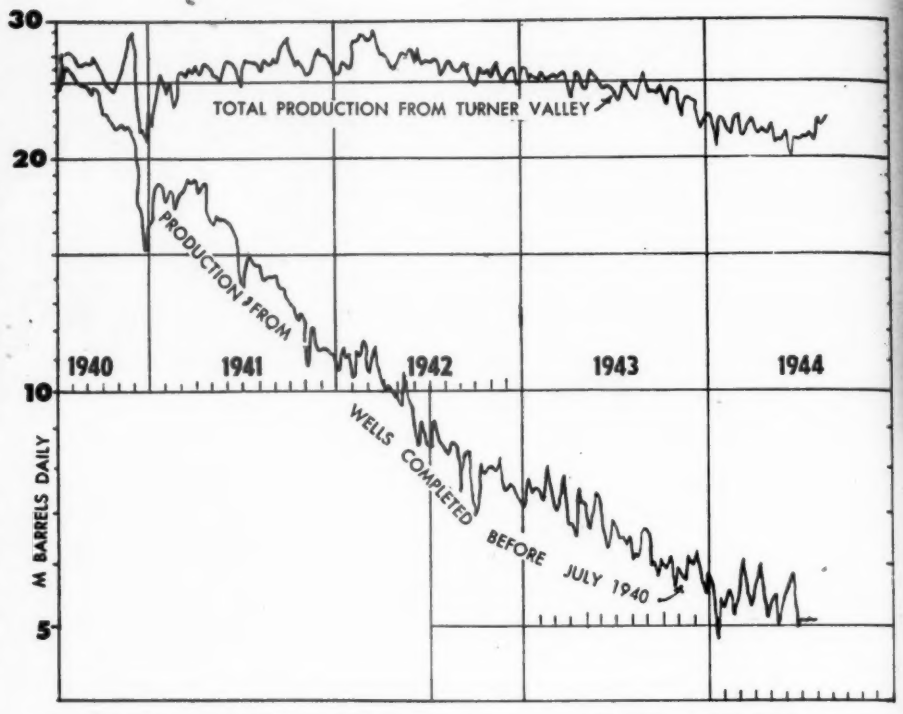
Every unit that has been produced during the past twenty-five years has had the same excellent engineering and painstaking care in manufacturing—practices that are now enabling producers to maintain their wells under adverse conditions, as A-C Units do extra duty.

volve tanker shipments down the coast from Skagway. Thus, although Canada is only 15 or 20 per cent self sufficient in oil supplies, it does not appear that these far northern fields are likely to receive immediate commercial development.

▼ **Turner Valley.** The figure shown gives graphically the total production from Turner Valley limestone oil wells for the last 4 years, and at the same logarithmic scale, the production from the 114 wells completed prior to July, 1940, in order to indicate the decline rate of a representative group of wells. As at the end of August, 1944, there were 246 wells in the producing list after the transfer of certain wells to the gas well list and deducting any abandoned wells.

This field was in 1943 the source of more than 98 per cent of Canadian production excluding Northwest Territories, and its yield has been declining for more than 2 years despite new completions. Imports are not published, but in 1942 Canada's total oil production appeared to be only about 18 per cent of her total requirements.

In 1943, 26 oil producers and two failures were completed in this field. In 1944 to the end of August, 31 oil producers and 1 failure were completed. It is of interest to note the effect of the Dominion government's participation through Wartime Oils in the number of completions. Three of the 26 completions in 1943 and 14 of the 31 completions in 1944 were wells sponsored by Wartime Oils. This leaves completions by private interests at 23 and 17 respectively for 1943 and 8 months of 1944.



Graph of the Turner Valley oil production.

Completion depths this year range from 6,271 to 10,238. This latter depth was for British Dominion No. 6. In this well limestone in the main fault block was encountered at 7910 ft; and after drilling 680 ft. of limestone, the well faulted to younger sediments and reached a second block of lime at 9795 ft., or 5587-ft. subsea. This compares with top of lime at Northend 1 (¾ mile south and ¾ mile east) of 4936 ft. subsea. Northend 1 is currently producing about 7 per cent water. Productivity in the lower zone of British Dominion No. 6 had not been determined as this goes to press.

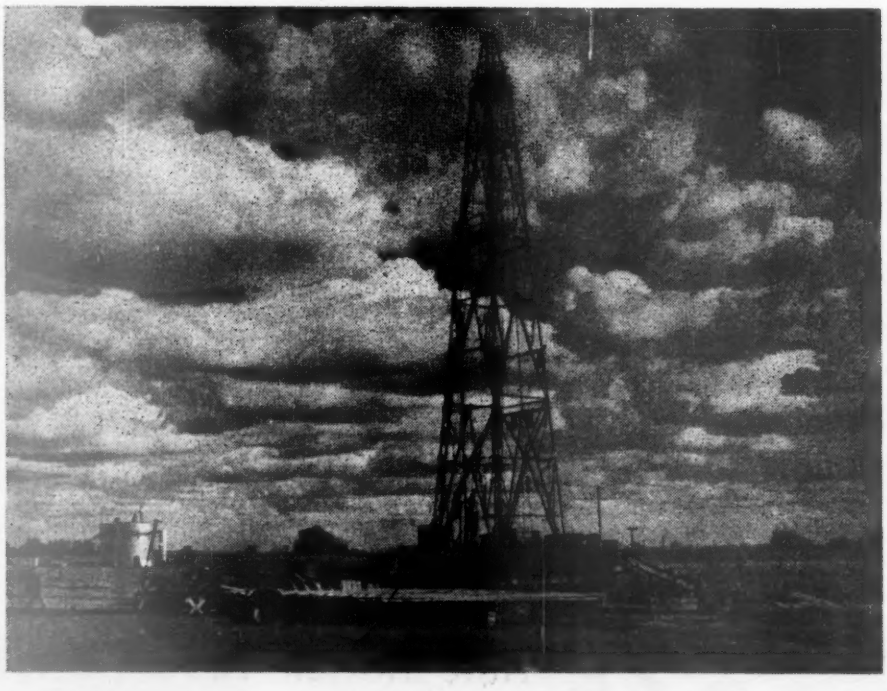
Extensions to the field during the last year have carried the north limit of the field only one location (¼ mile) northward; the south limit is no farther south, but the southern tip has been widened somewhat. The big news is that a central portion of about 2 or 2½ miles in length, previously thought almost barren owing to lack of porosity and permeability, has now had several completions of much better than average size.

▼ **Natural Gas Utilities Board.** In about 18 years from the completion of the discovery well in Turner Valley limestone to the close of 1942, it is estimated that nearly a billion and a quarter Mcf of gas was produced incidentally to the recovery of oil. This includes production for recovery of naphtha (or distillate, as it is called in many United States fields) from the gas cap and oil from the liquid phase zone. Of this production, only about 20 per cent has been usefully employed for its heat value and approximately half of the gas used has been used rather wastefully in field operations. Approximately 1 per cent of the total production was stored in the previously exhausted Bow Island field.

Desire to reduce the waste of gas prompted government authorities, the gas company, and most of the producers to attempt some solution, and the efforts have led to investigations by talent brought in from the United States as well as by Canadian engineers. One of the early attempts was in 1931, when an extended study was made, and at no time since has the effort been entirely discontinued. The variety of parties involved and the divergent nature of their individual interest was the great stumbling block to prevent more active measures to curb this waste in which fuel value equivalent to some 50,000,000 tons of coal has been totally lost.

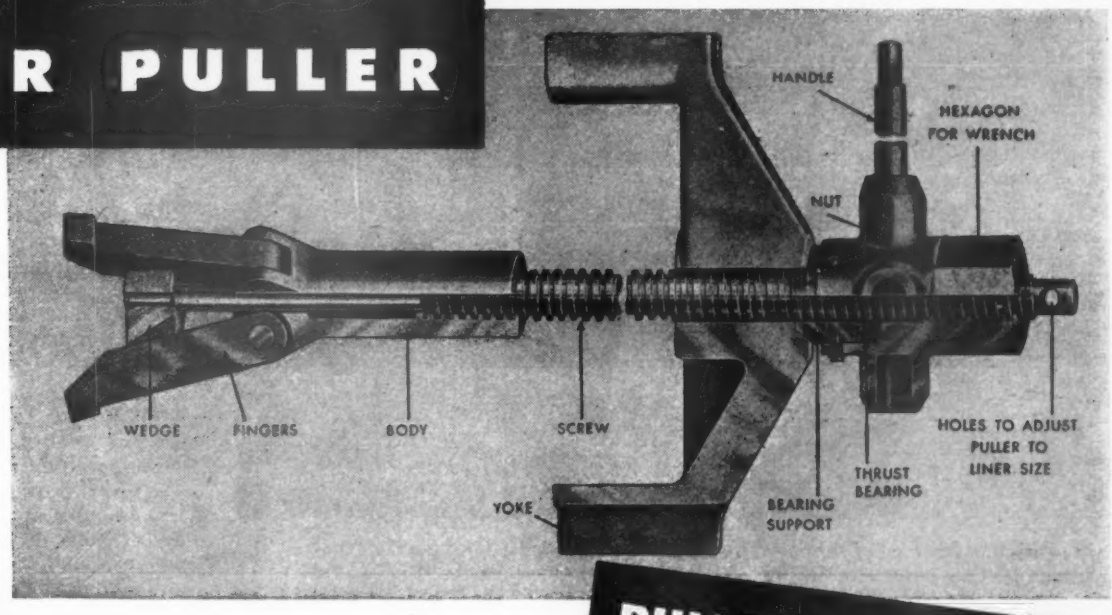
Early in 1943, Thomas R. Weymouth, an internationally recognized authority, was called in as consultant and he sub-

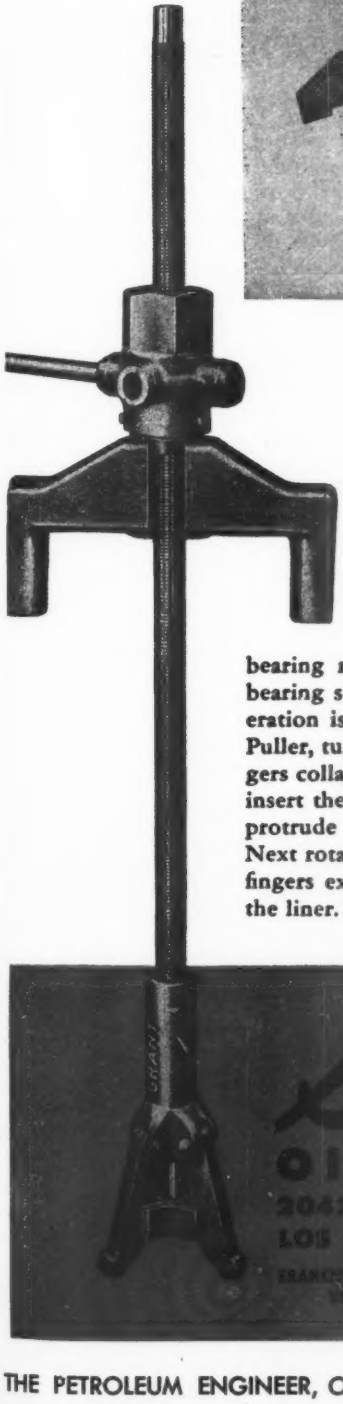
California Standard's Princess C.P.R. 8, discovery in the Plains Devonian. The drilling contractors, Can-Tex Drilling Company, used a Houston portable rig powered by internal-combustion engines to reach 3983 ft. depth in 46 days elapsed time including shutdown for cementing surface casing. Surrounding irrigated lands improve living conditions.



Grant LINER PULLER

MODEL 8443





PULLS ALL SIZES OF REMOVABLE LINERS (3½" TO 9" INCLUSIVE) FROM ANY PUMP

The GRANT Liner Puller will pull all sizes of removable liners from any pump. Two sizes cover the complete range—3½" to 5" inclusive, and 4½" to 9" inclusive.

All stressed parts are made of highest quality heat-treated alloy steels. Simple in design — no loose parts to become lost. Roller thrust bearing reduces friction and combined with bearing support provides extra strength. Operation is easy. To insert the GRANT Liner Puller, turn the screw clockwise until the fingers collapse enough to go in the liner. Then insert the Puller in the liner until the fingers protrude beyond the inner end of the liner. Next rotate the screw anti-clockwise until the fingers expand enough to contact the end of the liner. Then place the yoke over the end of the cylinder straddling the studs. Now rotate the nut assembly clockwise for the pulling operation. If additional leverage is required, a 48" pipe wrench can be used on the hexagon extension of the nut without injury to the roller bearing assembly. To remove the GRANT Liner Puller, simply rotate the screw clockwise.

Mail the Coupon for further details about the Liner Puller and other GRANT Tools.

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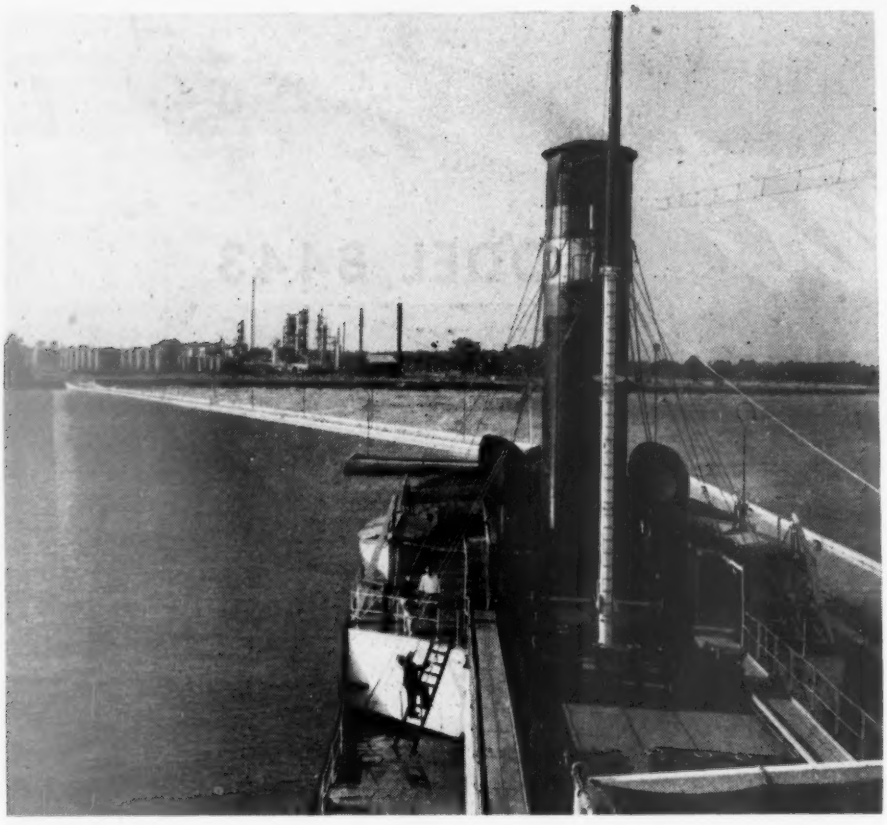


One of the lake tankers that delivers oil to the British American refinery at Clarkson.

mitted his final report, a 40-page document, under date of October 9, 1943. The report was mimeographed and distributed to interested persons by the Petroleum and Natural Gas Conservation Board under date of November 22, 1943. The report reviewed the situation, estimated the cost of putting a feasible scheme into effect, both with respect to immediate capital cost and cost of operation, estimated the additional life of natural gas utilities, and tentatively allocated the method of assessing the cost to parties who will benefit.

As the plan involved entering a field already under control of the Public Utilities Commission of Alberta, the government set up a new board consisting of G. M. Blackstock, public utilities commissioner, and Dr. E. H. Boomer, chairman of the Petroleum and Natural Gas Conservation Board. The new board is known as the Natural Gas Utilities Board, and it began functioning at once. The major companies involved have accepted the scheme and work is now well under way to carry it out.

The work involved dismantling one natural gasoline plant, trading sources of supply of gas among the remaining plants so that each would gather all gas supplies within certain areas, construction of pipe lines and installation of compressors. When completed the only gas that will be wasted will be small quantities from oil wells producing intermittently and at which special permission will in each case be granted on the ground that it is not economic to collect the gas. All gas not currently required to meet legitimate demand will be returned to the gas cap or to the Bow Island field.

Weymouth estimated that the life of the field as a gas producer will be extended. Without the plan he estimated the useful life of gas as a utility at 18.7 years; with the full plan it would be extended to 31.2 years, or an increase of 12.5 years.

It is not believed that all problems have as yet been solved but it can be said with confidence that there is real hope for their early solution.

▼ **Wartime Oils.** Wartime Oils, supplied with funds by the Dominion government, has authorized the drilling of 22 wells. Those completed have cost about $180,000 each, so the commitments run to approximately $4,000,000. To the end of July, 12 wells had been put on production with first production dates ranging from January to July. July production from the 12 wells averaged 1011 bbl. a day and a total of 121,167 bbl. had been produced to the end of July. The remaining 10 wells are in various stages from "finished drilling" to about midway down, 5 of them having finished drilling. There has been no intimation from the government that the plan is to be terminated. Some further applications to come under the plan have not been dealt with pending observation of results at wells not yet finished.

▼ **Price of oil.** In line with the policy of the Wartime Prices and Trade Board, retail prices have remained frozen. After a hearing before the public utilities commissioner, G. M. Blackstock, at which expert evidence on remaining oil reserves was presented, as well as certain accounting details, the price of transporting oil from the lease tanks in Turner Valley to the Imperial Refinery in Calgary was reduced from 9½ to 7½ cents per bbl., and the 2 cents saving was given to the producers. This change was effective May 1, 1944, and brought the price of 41° API oil up to $1.68 as in tanks at the well, with a differential of 2 cents per degree down to $1.52 for 33°-33.9° and up to $2.14 for 64° and over. There was no change in natural gasoline, which remained as posted November 29, 1943. This is a rather complicated posting, which provides $2.28 a bbl. for 26-lb. Rvp., computed as 150 per cent of charcoal test, plus $2.74 for isobutane plus $0.28 for remaining propane and normal butane. Pipe line deductions were cut by the public utilities ruling from ¾ per cent (old) to ½ per cent (new) allowed deduction. A deduction of 2 per cent is still applied to natural gasoline handlings.

TABLE 1

Consumption of petroleum fuels in Canada, thousands of bbl.
(Condensed from Dominion Bureau of Statistics)

	1943 12 months	1943 first half	1944 first half
Gasoline	27,208	11,859	13,155
Tractor distillate	1,170	522	535
Light fuel oil	8,256	4,110	4,161
Heavy fuel oil	14,961	6,699	8,303
Total	51,595	23,190	26,154

TABLE 2

Canadian crude oil production, including natural gasoline, bbl.
(From Dominion Bureau of Statistics)

	1943 12 months	1943 first half	1944 first half
Turner Valley	9,452,697	4,803,719	4,181,340
Other Alberta fields	221,851	63,772	205,773
Northwest Territories	not published	89,929	569,784
Ontario	137,637	66,737	67,719
New Brunswick	25,219	13,713	11,221
Total	9,837,404*	5,037,870	5,035,837

*Not including Northwest Territories.

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

PETROLEUM ENGINEER EDITION

"IT COST US OVER $20,000 TO DISCOVER THE IMPORTANCE OF THE BAASH-ROSS SAFETY CLAMP"

reports a major operator

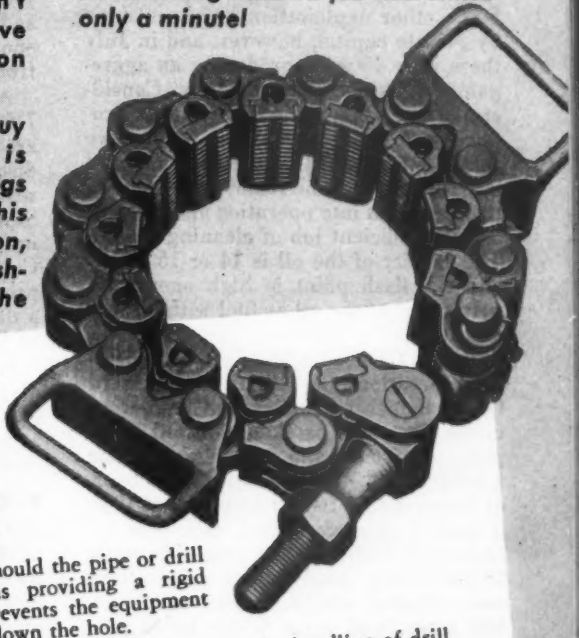
"Now we keep one on every drilling rig!"

HERE'S THE STORY. When a Baash-Ross representative first called on this large oil operator to show him the Baash-Ross Safety Clamp, the operator was frankly dubious about the importance of its vital safety features . . . and put the matter off. Not more than a few weeks later one of his crews had a drill collar slide through the slips while making up the string—*exactly the kind of risk the Baash-Ross Safety Clamp guards against.*

The resulting fishing job cost the operator over $20,000 besides weeks of valuable time in completing the well—*a loss that a Baash-Ross Safety Clamp could have prevented!*

"Needless to say," the operator reports, "that's one lesson we won't have to learn again. We now have a Baash-Ross Safety Clamp on every operating rig!"

Like good insurance, the time to buy a Baash-Ross Safety Clamp is before you need it. So if your rigs are not now safeguarded with this low-cost, highly useful protection, why not contact your nearby Baash-Ross representative today? The Safety Clamp comes complete in a handy all-steel storage box and can be readily adapted to fit any size pipe from 3¼" up by simply adding or removing links—a job that takes only a minute!

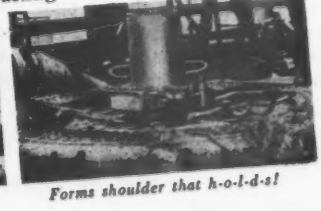


HOW FISHING JOBS START! If you are supporting drill collars (or other flush joint equipment) in the table with regular rotary slips, you're inviting trouble every time you do it. Because the diameter of drill collars steadily decreases as they wear against the walls of the hole, slips that fit the curvature when new (A) rapidly lose their gripping efficiency as the collar wears (B). And once the drill collar starts sliding through the table there are no shoulders to stop it. *Result—a costly, difficult fishing job!*

Slips that fit new drill collar ... lose grip as collar wears.

HOW THE SAFETY CLAMP PROTECTS! The Baash-Ross Safety Clamp guards against this danger by providing a quickly-attached, quickly-removed shoulder for externally flush equipment. Here's all you do. Whenever you set externally flush equipment in the table with *any* type of slips, simply wrap the Safety Clamp around the equipment above the slips, drop a single pin in place and tighten with a quick-acting wrench. That's all it takes.

Easily and quickly attached



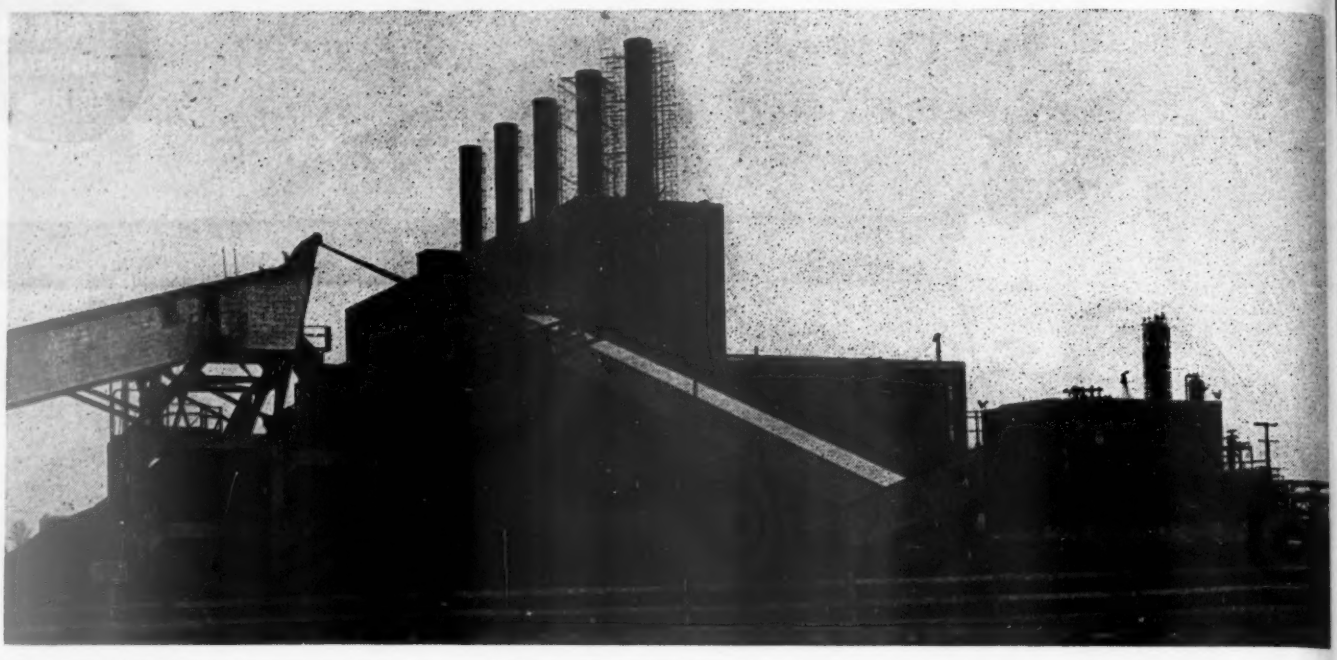
Forms shoulder that h-o-l-d-s!

Each link in the Safety Clamp has an individual gripping member that takes a firm hold as the Clamp is tightened. And this grip only wedges tighter should the pipe or drill collars fall, thus providing a rigid shoulder that prevents the equipment from dropping down the hole.

MANY OTHER USES! Besides safeguarding the handling of drill collars, you'll find many other valuable uses around the rig for a Baash-Ross Safety Clamp. For example . . . **USE IT** to safeguard against dropping other types of flush surfaced equipment such as production liners and screens . . . **OR** as an emergency elevator shoulder when recovering twist-offs and similar fish (C). One operator safely supported a 4000' drill string this way while lifting it far enough to get a collar in the clear! . . . **OR** for holding gravel-packed liners in the table while making them up. These liners usually have insufficient room between collar and pack for elevators. So put the Clamp in this space and support the liner through a "U" plate on the table (D). Gives ample room for tongs!

C.

D



Polymer Corporation plant, Canada's largest steam and power plant. Owned by the people of Canada, this giant synthetic rubber plant near Sarnia, Ontario, is one of the largest of its kind in the world. It has a rated capacity of 1,375,000 lb. of steam per hr. at 450 lb. pressure. Most of the steam is used in the making of synthetic rubber, and the remainder activates 3 turbo-generators with a total capacity of 29,000 hp. *—Photo by National Film Board.*

▼ **Other Alberta developments.** *Vermilion field.* The Canadian National Railway formed a subsidiary known as Cannar Oils Limited and undertook a 50 well program in order to increase the supply of oil for use in the mountain division as locomotive fuel. After drilling 29 wells, the railway decided that they would discontinue further drilling. In July of this year they produced only 17 of the wells. Some of the holes were dry and others were marginal producers. Some other exploitation has been done by private capital, however, and in July there were 45 wells producing an aggregate average of 708 bbl. daily. Considerable fine sand, water, and salt are produced with the oil, and for locomotive fuel it is essential that the fine sand and most of the water be removed. A Petreco plant was put into operation and it seems to do an efficient job of cleaning the oil. The gravity of the oil is 14 or 15° API. and the flash point is high enough to permit use of the oil as fuel without topping.

Taber. California Standard, which began operations in Alberta as Standard Oil of British Columbia, and later went under the name of Dominion Oil Company, completed the discovery well for a pool about 3 miles south of the town of Taber in mid 1942. By the end of 1943 it had 4 producers, and this was increased to 7 by May this year. The wells showed very good initial production, were situated within an area of 250 or 300 acres, and some 6 dry holes surrounding the producers outline the pool. The gravity was about 19° and virtually no water was produced with the oil. As the production increased there was some difficulty in marketing it, but this was partly solved by tank car shipments to the Calgary refinery of Imperial Oil and by truck deliveries to other small refineries. The oil has too low a flash point for use as locomotive fuel without topping. Production rates have fallen sharply and it has not as yet been considered economic to put in a topping plant for the pool.

Another pool seems to be developing 3 or 4 miles to the west and there are now 3 wells that seem capable of producing. A gas cap exists, which may adversely affect production from this pool, as the sand does not appear to be thick enough to permit separating the oil zone from the gas zone successfully.

Another pool some 21 miles south and 7 miles east seems to be indicated. The area is referred to as Conrad, and the discovery well is about 7 miles to the west of the Skiff field discovered in 1927. Skiff never produced much oil. Its gravity was 18 or 19°. The new strike near Conrad has a gravity of 25.6 and initial production appears to be about 150 bbl. a day. Oil is being shipped to Imperial at Regina.

Red Coulee field. After some 15 years of production and yield of nearly 329,000 bbl. this field is being abandoned, as production was no longer considered economic.

▼ **Wildcats.** This has been the most active year on record for wildcat drilling in Alberta. Although much of the activity has been expended in feeling out for extensions to small pools or discovery of related pools, there has been no hesitancy in going out into the blue. Most of the activity has been among companies that are supported by major producers, but there have also been a few that are privately financed. Shell completed the deepest hole in Canada in October, 1943, at 12,056 ft. This was its Jumpingpound location known as Shell Norman 1, in 5 of 22, 24-5 W 5th. It reached the Rundle limestone (often referred to as Madison lime) but found water. This company has since begun another deep test somewhat farther north and more easterly on structure in 4 of 24, 25-5 W 5th, and is making good progress. Imperial interests put down Royalite Wildcat Hills No. 1 in 16 of 30, 27-5 W 5th, to a depth of 11,155 ft. This well also penetrated the Rundle limestone but found water.

Farther north, also in the foothills belt, Ram River 2, a diamond drill hole produced a small quantity of oil in tests and is now drilling a third hole. The location is in 12 of 1, 37-11 W 4th. Imperial is drilling near Coalspur and Jasper Syndicate has started a well in 2 of 19, 49-26 W 5th. This latter well starts in Triassic sediments.

Some activity continues near Lloydminster where a small oil discovery has been developed to 3 or 4 producers.

Princess. The California Standard (under an earlier name) drilled its Princess C.P.R. No. 1, starting the well in 1939. The locality had been studied geologically by Joseph S. Irwin, consulting geologist, who brought it to the attention of John Galloway, manager of the subsidiary of California. He had the area mapped by seismograph, which confirmed the possibility of favorable structural conditions. In drilling the first well, abnormally high pressure of gas twice wrecked the rig, and the hole was not in the best of condition for testing, but an oil occurrence was noted in the Jefferson lime (Devonian age). Some 7 wells were drilled by this company within a radius of about 3 miles and 4 wells were drilled by other interests. A gas field seemed to be indicated and there was oil underlying the gas, with water beneath. Approximately 30,000 bbl. altogether were produced in 1941-42, the oil coming from a zone a short distance above the Palaeozoic, and having a gravity of 27° API., but the lack of adequate natural separation between gas, oil, and water made

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continued production uneconomical and operations were suspended until this summer, when the company put down its No. 8 well offsetting No. 1 to the west, at a distance of about 1100 ft. This was for the purpose of testing the Devonian showings and it successfully passed the high pressure gas horizons and in a drill-stem test found an oil of about 35° API., which flowed at a rate up to 45 bbl. an hr. during a fairly brief test. Casing has been set and a period of testing will follow before the discovery can be valued fully, but the fact that oil of so high a gravity has been taken from the Devonian is of great importance, as it puts an entirely new complexion on the possibilities of the very large Plains area in Alberta.

Making what is probably a world record for depth of hole drilled by cable tools and for open hole, Maxmont No. 1 near Lundbreck is below 9771 ft. and the last casing is 8 in. at 2857 ft., so that there is more than 6900 ft. of open hole. It is nearly 10 years since drilling began and most of the hole has been made by one driller, A. W. P. Patrick, who with a tool dresser and fireman has worked one tour a day. The sediments are Cretaceous sands and shales and much ingenuity has been used in building wall by cementing, in overcoming fishing jobs, and in obtaining drilling lines that will stand up under such great depth.

Space prevents a full report of all wildcat developments.

Beginning late in July a photographic reconnaissance of the foothills belt was undertaken under joint sponsorship of Imperial, Shell, McColl-Frontenac (Canadian partner of The Texas Company), Gulf, Rio Bravo (Canadian subsidiary of Superior), and Socony-Vacuum. The plan is to cover about 9000 square miles from the Montana border north, leaving out areas that are already mapped or being mapped by air by the Dominion Geological Survey.

Brief reference has already been made to the fact that a number of companies have many geological parties out, and that several geophysical parties are active.

An interesting report by Dr. G. S. Hume covers the results of a seismic survey in the Wainwright area. Reflection shots in the area where oil has been produced for some years indicate that the wells were drilled on the flanks of a Palaeozoic erosional remnant and irregularities of sedimentation around this remnant or plateau are probably the reason for oil concentration. The survey outlined two similar highs within a few miles to the south.

▼ **Saskatchewan.** Norcanols, a company supported by Imperial and other interests, has been running two rigs and has carried some 7 tests to depths of 5000 to nearly 8000 ft. with negative results. Six other wells were active during August, but there are no unusual developments.

▼ **Quebec.** Continental Petroleums Limited are drilling in the Gaspé peninsula and at last report their No. 2 well had reached a depth of 2275 ft. Hume* reports that drilling in this area began in 1860, and from 1889 on for a few years more than 50 wells were drilled, some to a depth of 3000 ft. In 1939 Imperial Oil started a well that was eventually abandoned at 5995 ft. and in 1941-42 drilled another well to 4770 ft. Several wells have produced a little oil, but the yield has been of the order of a few gallons a day.

▼ **Tar sands.** On May 25, 1944, Hon. T. A. Crerar, minister of Mines and Resources, presented a bill in parliament providing for an appropriation of $500,000 for remodeling and expansion of plant of Abasand Oils, Ltd. At that time he stated that the Dominion government had already spent $766,000 on the project, which has a separation plant near McMurray, Alberta. The separation plant, he stated, would shortly be ready to operate, but the refinery would not be ready until about September 1. The two plants were intended to handle a throughput of about 600 bbl. daily and should be considered only as a pilot plant of a size that would test out refining possibilities in a semi-commercial way. He stated that laboratory tests by Universal Oil Products Company showed that 22 per cent by volume could be recovered as 100-octane aviation gasoline and 17 per cent by volume as motor fuel of 73-74 octane rating; also 16½ per cent of fuel oil. Universal Oil Products Company estimate the cost of a refinery to treat 5000 bbl. of bitumen daily would be $8,700,000 in United States money, or after paying sales tax, duty and exchange, about $12,000,000 in Canadian money. Owing to several uncertainties, first of which is the erratic nature of the deposits, it was considered better to proceed with only a pilot plant at present. Separation on a small scale was resumed in August and will presumably be stepped up when the refinery is ready to operate.

*Petroleum Geology of Canada.

▼ **Refining.** One of the feature news items of the past year in Canada under the head of refining was the completion at Clarkson, Ontario, of a new refinery by British American Oil Company, Ltd. The new refinery produces a high grade of aviation lubricants, and produces aviation gasoline and ordinarily does not produce motor gasoline.

Clarkson is on the shore of Lake Ontario, midway between Toronto and Hamilton, and oil supplies come by lake tankers from American lake ports. Intake water for cooling comes through a 3½-ft. intake pipe extending a quarter of a mile out into the lake, and it provides uniform cooling. Foundation conditions are favorable, and the equipment installed is fully modern with cracking units to provide high octane gasoline, as well as solvent refining, dewaxing, and clay contact filtering for the refining of high grade lubricants.

Henry Deguire, left, and Lyle Bell, right, operators, check the synthetic rubber bales. The government-owned Polymer Rubber Corporation, Sarnia, Ontario, turns out 75-lb. bales of synthetic rubber every 87 seconds.
—Photo by National Film Board.

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Most of the lube stock comes from Oklahoma City field and other supplies come from Indiana and Illinois. The crude charging capacity was designed for 10,000 bbl. daily and lubricating oil output at 1500 bbl. daily.

Hon. C. D. Howe, Canada's Minister of Munitions and Supply, who sponsored Polymer.

▼ **Synthetic rubber.** Canada is fortunate in having a cabinet minister who is an engineer of high ability. Hon. C. D. Howe, Minister of Munitions and Supply, is to be credited with establishing The Polymer Corporation, Ltd., which now has a plant producing buna S and butyl rubber.*

The plant is about two miles from Sarnia, Ontario, on the bank of the St. Clair River. It adjoins the large oil refinery of Imperial Oil, supplied by pipe line from Oklahoma. Incidental to refining of oil, this refinery produces a butane-butylene cut that passes on to the Polymer plant.

Water to supply boilers evaporating 1,400,000 lb. of steam hourly, and to supply a pumping plant capable of handling 140,000,000 gal. daily for cooling, comes from St. Clair River. Salt for the process comes as brine from nearby salt wells. Coal for fuel and benzene to enter the process are delivered by lake barges. The finished raw synthetic rubber is fairly close to plants that make tires and other finished rubber goods.

As originally estimated, the cost was to run to $46,000,000, and at the end of January, 1944, expenditures were about $47,024,000 in addition to which there were commitments for $1,500,000 on construction account. The total cost will probably reach $49,500,000—remarkably close to the original estimate considering that war conditions have made estimating very difficult. In March of this year, it was reported that, although the plants were in production, there was additional work to be done to bring them into a full stage of completion.

It is worthy of note that the butane-butylene cut is fractionated to get normal butylene for making butadiene, and all the isobutylene must in any case be extracted. Having separated the isobutylene, it becomes available to produce butyl rubber. For this reason the two operations naturally go together. Butyl rubber seems to be the best substitute for natural rubber when making inner tubes, gas masks, and similar articles but it does not blend well with natural rubber. Buna S is better for tire casings.

Styrene for co-polymerizing with butadiene is also made in the plant.

Price of rubber. It is hoped by Polymer officials that after the war they can keep synthetic rubber prices at about 20 cents a lb. and perhaps as low as 17 cents.

Operating set-up. Polymer owns all property and all materials that go into the process as well as the finished product.

Operation is done through 3 companies. Canadian Synthetic Rubber, Ltd., is owned in equal shares by 4 Canadian rubber companies and it acted in a supervisory capacity in engineering the plant, getting technical assistance from parent American companies, training personnel in operation of the buna S plant, and operating it.

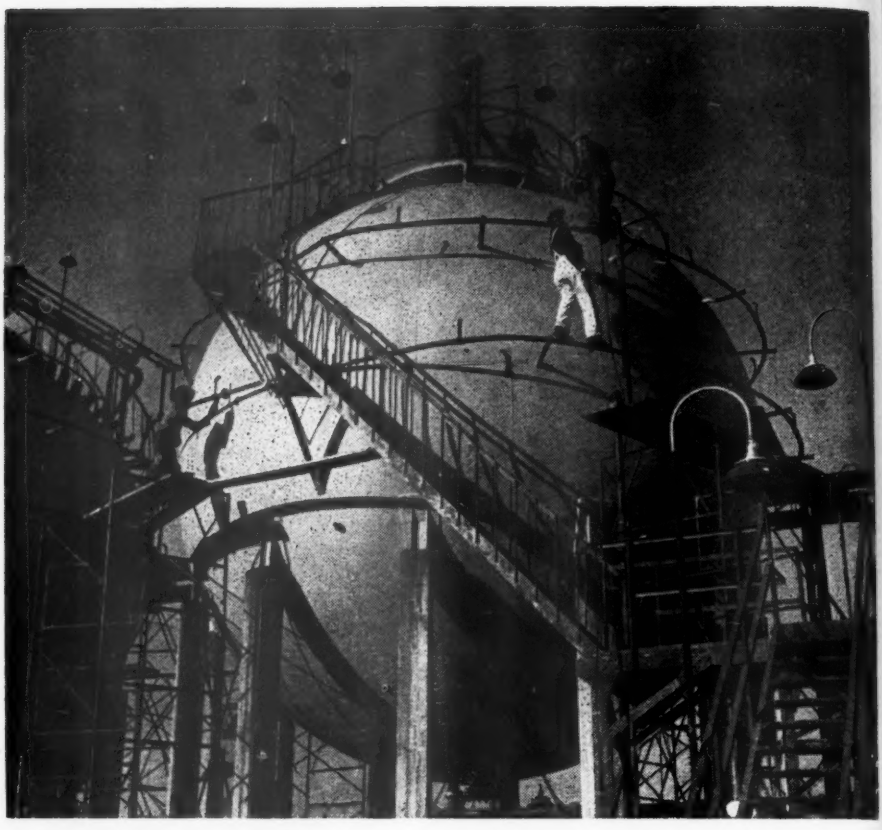
St. Clair Processing Coporation is a subsidiary of Imperial Oil and it operates the feed preparation units, butadiene plant, and butyl rubber plant.

Dow Chemical of Canada, Ltd., operates the styrene plant.

Polymer pays these 3 companies management fees. In case of Canadian Synthetic Rubber, Ltd., the fee is ½ cent per lb. or a little more. No definite fee had been arranged with St. Clair as at the last public statement. The fee to Dow will be the same as the average fee at their 4 United States plants, and it is understood to vary somewhat with volume of production.

Patent royalties follow agreements with the United States government. On buna S and butyl there are no royalties for the duration of the war and for 6 months thereafter, whereas on styrene the royalty is ⅛ cent a lb.

Early completion of this large plant, designed to produce 34,000 long tons of buna S per year, has greatly speeded up Canadian production of war supplies. Authority for its construction was passed on March 27, 1942, and it was in production 18 months later, with the finished product entering into use on military vehicles during the critical battles for the liberation of France.



One of the 13 hortonspheres on the 185-acre property of the Polymer corporation, Sarnia, Ontario, Canada.

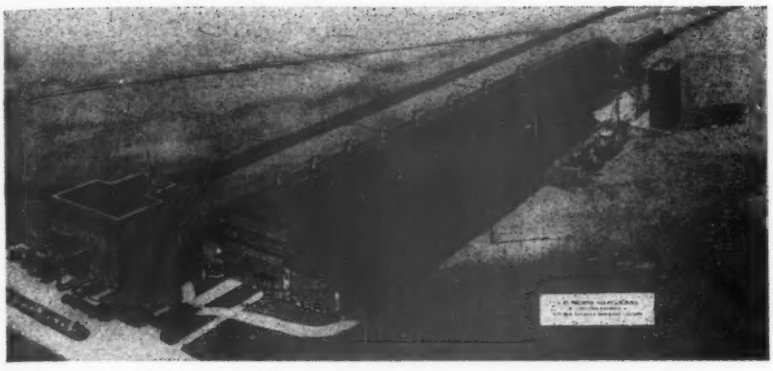
—Photo by National Film Board.

In normal peacetime economy prior to September, 1939, Canada's average yearly consumption of crude rubber was 34,400 long tons. Additional wartime demands brought consumption mor nearly to 50,000 in 1940 and 1941. The capacity of Polymer is therefore about the prewar demand.

▼ **Alberta Nitrogen Company.** This company has a plant near Calgary using a large block of electric power and a supply of natural gas. It was built for the manufacture of explosives for war purposes. Consolidated Mining and Smelting Company, Ltd., supervised construction, placed all information and a trained staff at the disposal of the Dominion government, which footed the bill for construction. The original undertaking provided that only materials for explosives would be made, but when a surplus of explosives developed and at the same time there was a shortage of commercial fertilizer due to war conditions, production was switched in part from explosives to fertilizer with consent of both parties to the original agreement. Some research was needed before the original materials could be converted to fertilizer, but the process was perfected and fertilizer has been sold both in Canada and abroad. The development of a satisfactory process of fertilizer production represent a remarkable achievement on the part of the Canadian engineers and chemists concerned. ★ ★ ★

*"Canada's Synthetic Rubber Program," by C. C. Pryor, *The Petroleum Engineer*, October, 1943.

Brewster Builds Now for Your Tomorrow



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And you'll get it. Brewster is building now for your tomorrow—a truly modern machine shop housed in a fireproof structure 150′ wide and 400′ long on eight acres paved three sides—a 25-ton crane with a 60′ span—railway facilities right through the plant.

Ready Soon:

By January 1st Brewster will be out with complete new Drilling Rigs and other important oil field equipment, all years ahead in design.

Ready Now:

... Brewster Rotaries, Crown Blocks, Traveling Blocks, Swivels, Well Hook-ups, all for immediate delivery.

Victory First!

Understand, please, we are working primarily now for Victory. Bomb cases, two sizes and types ... loading chocks ... cargo winches ... lease-lend oil field equipment for Russia ... anything the Army and Navy want that we can give them.

Perhaps it would be enough to say that the men and women of Brewster have been thrice awarded the coveted Army-Navy "E".

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Recording crew going to work in a canoe

GEOPHYSICS—VANGUARD OF SOUTH AMERICA'S FUTURE OIL PRODUCTION

By **WALLACE A. SAWDON**
Foreign Editor

EXCLUSIVE

Geophysics is already paving the way for extensive postwar exploratory drilling in South America. Geophysical prospecting has done much for every oil producing country on that continent but it is doubtful whether geophysical activities have ever been so great as they are at the present time. Moreover, additional crews and equipment are being organized. When the vast extent of possible oil-producing areas on this one continent are considered and cognizance taken of the difficulty of making geological surveys over a great extent of the territory, the value of geophysical prospecting can be realized. Some of the country is flat; some is mountainous. Great areas are covered with jungle and other parts are arid. Some of the work has to be done on water-covered land. Transportation is seldom easy and almost always the difficulties, frequently the hazards, attending isolated areas must be overcome.

Although the seismograph is more widely used than any other instrument for geophysical operations, the gravimeter (gravity meter) and the magnetometer are also being employed in several South American areas. As elsewhere, the torsion balance has been superseded by the gravimeter and no use of this instrument has been reported at present in any of the countries.

In considering the geophysical work being conducted in South America it must be remembered that a large part of the work covers widely extended areas and probably most of it, which is distant from areas of present production, has for its objective the big features of the subsurface formations. Only loose control is thus necessary to order to obtain data that will indicate an area's possibilities for further study. Some of the geophysical work now in progress is in areas that have been previously surveyed, either by the same or different geophysical methods. Surveys made with control close enough to identify smaller features can always be made when an area is of sufficient interest and when economic conditions make further action desirable. Many of the surveys being made in South American countries are more or less preliminary and even when favorable big features are disclosed do not preclude the necessity for more study before exploratory well locations are made.

In addition to further exploratory work being done in the general producing area of eastern Venezuela a considerable amount of geophysical prospecting is being carried on to the west and south in the Orinoco Basin. Crews have been reported to have been working on both sides of the Orinoco River and it is expected that some wildcats will be drilled in the near future on locations made by geophysical data. Surveys in the basin are being conducted as far west as the Barinas area, which lies over mountains southeast of Lake Maracaibo.

Colombia is probably the most active country from the standpoint of geophysical prospecting. The seismograph, gravimeter, and magnetometer are all in use in various parts of the country with considerable work continuing in the northern part of the country in the middle and lower Magdalena Valley areas and in other valleys extending inward from the coast. The coastal area just north of the Ecuador boundary has been surveyed and it is expected that this work will be carried northward. Several companies have crews in the llanos region in which run headwater streams of both the Orinoco and Amazon systems, the most concentrated work at present being near the mountains southeast of Bogota. In the higher land near Ipiales just off the Ecuador border a gravimeter crew is expected to be operating soon, if indeed it is not already at work.

In the past, geological work has been done over a considerable part of Brazil, but during the last few years extensive geophysical prospecting has been carried on in areas where the prospects for oil have appeared most favorable. Geophysical operations in the interior areas require considerable time and are conducted under great difficulties. This is particularly true of the extremely western area, which lies near the Aguas Calientes field of eastern Peru and south of the llanos regions of Colombia and Ecuador. This territory appears to have very favorable prospects but the transportation problem, both for hauling in of equipment and carrying out of any oil produced, has to be considered. Should an extensive producing territory east of the Andes and around the headwaters of the Amazon and Orinoco rivers ever be developed the problem of transportation will, of course, be solved; but at the present time petroleum exploration here is still in the geophysical stage with actual production only at Aguas Calientes along the southwesterly limit and a well or two drilling at the northwestern limit near Bogota.

Other parts of Brazil are being more actively explored with geophysical methods at this time. No authentic data have been received on these activities during the past year or two but it is believed that, in addition to the area along the Atlantic Coast around Bahia and Maceio where extensive geophysical surveys have been made and exploratory wells drilled, geophysical crews are at work in the Parana area west and south of Sao Paulo and in the area south and west of the Amazon delta and along the northeastern coast.

Argentina has long been using geophysical prospecting and the Y.P.F. (government operations) has a number of crews with American equipment in continuous operation. No reports on recent activities or areas of prospecting are available. Geophysical work is also being done in Chile. The Guianas have been geophysically prospected to some extent in past years, but there appears to be no activity at present. ★★★

ECUADOR'S PETROLEUM LAWS

By **ALONZO CHIRIBOGA G.**

EXCLUSIVE ENACTED in 1937, the present mining and petroleum laws of Ecuador show liberal traits, characteristics, and trends. At no time during the concessionaires operations does the governmental control reach the inquisitorial character that it takes sometimes in other countries in South America and in Europe as well. The duration of the concessions — 50 years—gives ample time to the operators or companies. Finally, the Ecuadorian laws do respect all legally acquired rights.

The Author

In 1933 the Government of Ecuador initiated a four-year mining program the main goal of which was that of furthering the extraction of mineral oils to promote and hasten a greater development of the country's industries.

The General Bureau of Mining and Petroleum had classified the activities as follows:

a. Classification of the regions bearing mineral fuels in order to study their yielding possibilities. The results of these studies were available to the companies to enable them to carry out their operations in a more efficient manner.

b. Decrease in the transportation cost of materials for protection of the oil industry.

c. Creation of national markets of consumption in order that the companies could be assured of the sale of all their products.

In addition to the above-mentioned activities, the General Bureau of Mining and Petroleum was engaged in creating a complete statistical service regarding the oil industry as well as a petrographical museum.

From the fiscal standpoint the carrying out of this mining program brought about most advantageous results. In 1932 oil industry taxes added up to over three-fourths of the total taxes, all mining and oil fiscal taxes amounting to 1,166,902 sucres; in 1937 this sum was increased to 6,075,579 sucres, almost reaching in 1938 the nine-million mark. The latter figure surpassed the most optimistic expectations contained in the second 6-year mining program of the General Mining Bureau. All the above figures do not take into account either the sales tax or the income tax.

Among the points carried out according to the first mining plan the amending or reforming of the petroleum legislation was one of the most outstanding, beneficial, and successful. The General Law of Mining could not agree with the special regulations formerly enacted to regulate the exploitation of hydrocarbons. The object of the present new law, enacted on August 6, 1937, was that of codifying these scattered regulations and of making them agree with the dispositions established by the General Law of Mining, which, enacted on February 5, 1937, is the present mining law of Ecuador.

Following are the main dispositions of the Ecuadorian Law of Petroleum:

The deposits of solid, liquid, or gaseous hydrocarbons are possessions under the direct domain of the State, which domain is inalienable and imprescriptible; consequently the rights to be granted according to this law shall constitute in no case an absolute and definite property.

The oil industry in its divisions of exploration, exploitation, storage, refining, and transportation is declared to be an industry of public use; consequently it shall be favored with legal expropriations, if and when necessary.

The State has the right of granting concessions for periods not longer than 40 years, excluding the period for studies and explorations established in the respective contract; and for 20 years, also excluding the same period, in the case of a concession by denouncement. At the time of their expiration, these concessions may be extended for 10 and 5 years, respectively, the exploration period being 5 and 2 years, respectively. In the Oriental Region (Amazonic basin), the government may extend for 3 and 1 years, respectively, the above exploration terms.

In no case shall concessions be granted to foreign governments or states, or to corporations depending on them, or to foreign companies not legally domiciled in Ecuador, or to public officials.

The concessions may be of two kinds:

a. By contract.

b. By denouncement.

The concessions included in category "b" cannot be of a size less than 4 hectares nor larger than 80 hectars.

The Government may grant by contract a maximum of 50,000 hectares. However, if on account of particular circumstances it were indispensable to extend said extension, the Government may do it, previously hearing the opinion of the General National Attorney. The minimum size obtainable by contract is 400 hectares.

In the Oriental Region the Government shall grant concessions as deemed convenient.

Any natural or legal person can present proposals for contracting concessions of exploration and exploitation of oil of national property.

The surety bond deposited by the concessionaires is constituted by a fixed basis of 10,000 sucres and 100 sucres more for every 100 hectares of the concession surface. For the concessions granted in the Oriental Region special bonds may be established by mutual agreement between the parties.

A concessionaire loses his right to the bond that guarantees the exploration period, if he lets elapse two years without initiating his operations.

If the concessionaire fully proves the unproductivity of the leased land, the Government, after hearing the technical report of experts, shall order the immediate devolution of the above bond, the contract being terminated.

Legislation for control of Ecuadorian oil development is among liberal S. A. type says former member of its petroleum bureau.

Once the exploration period is over and the exploitation of the concession initiated, the Government shall order the devolution of the above bond. If the investment can be proved of an equal amount in the concessionaire's operations at any time during the exploration period, the Government may also proceed likewise.

For the exploitation period the concessionaires shall constitute a guaranty, in behalf of the State, according to the dispositions of the General Law of Mining.

No concessionaire shall be able to curtail his production, from one year to another, to an amount less than one-third of the producing capacity of his wells, unless under a previous permit from the Government, which permit shall not exceed one year. In case of disagreement upon the producing capacity of the wells, the difference shall be settled by experts appointed by each party, or, finally, by a third expert, if necessary.

In the concessions by contract there shall be established the minimum yearly investment that every concessionary must make in the development of his exploitation work, as well as the number of years during which said investment is

*Alfonso Chiriboga G. was first assistant to General Director of Mines in the Ecuadorian government, where he gained the background to discuss authoritatively petroleum legislation of his country. He had studied civil engineering at Central University of Quito for three years when in 1939 he was awarded a government scholarship to attend the University of Southern California. Chiriboga was graduated with honors in petroleum engineering from the latter school last year. He returned to South America to join the staff of the Richfield Oil Corporation, but is at present engaged in business of his own.

compulsory. For the concessions in the Oriental Region equitable investments shall be established in relation to the existing difficulties of access and transportation.

The concessionaires shall not be able to increase disproportionately the production of their wells, but they must abide by the proportions determined in the regulation of oil operations to be enacted by the President of the Republic. In case of disagreement, the matter shall be settled by experts.

Wherever an oil structure happened to lie in two or more lands leased to different concessionaires, the latter shall obligate themselves, if the Government so demands, to put into practice a cooperative plan of exploitation, which shall be regulated by the Ministry of Mines.

Upon the termination of the concession contract, except in case of unproductivity, the concessionaire shall leave the producing wells in perfect state or condition, as well as all constructions and other immovable properties, all of which, together with machinery, accessories, etc., shall pass free to the hands of the State, as well as easements and properties or utilities expropriated in the concessionaire's behalf.

The Government may at any time impetrate the conservation measures needed to prevent the oil field or the installations thereon from becoming damaged or useless.

The concessions by denouncement shall be granted for the time and extension already stated above. The beneficiaries may establish within the boundaries of the leased lands storage stations or refineries, as well as cooperative associations for the exploration and exploitation of their lands.

The concessionaires by contract shall pay annually during the periods for exploration and exploitation a surface fee of 0.20 sucre per hectare of the national lands contracted for, during the first two years; 0.40 sucre during the third year; 0.80 sucre in the fourth one, and 1.00 sucre from the fifth one on and until the termination of the contract with its extension, if any.

In the Oriental Region the Government shall levy conventional surface rights.

Should the concessionaire use the premises of planters or colonists settled prior to the contract or to the opening of the wells for the exercise of easements, expropriations, etc., he must pay them in advance the indemnities established by the Ministry Court of Mines upon hearing the judgment of qualified experts.

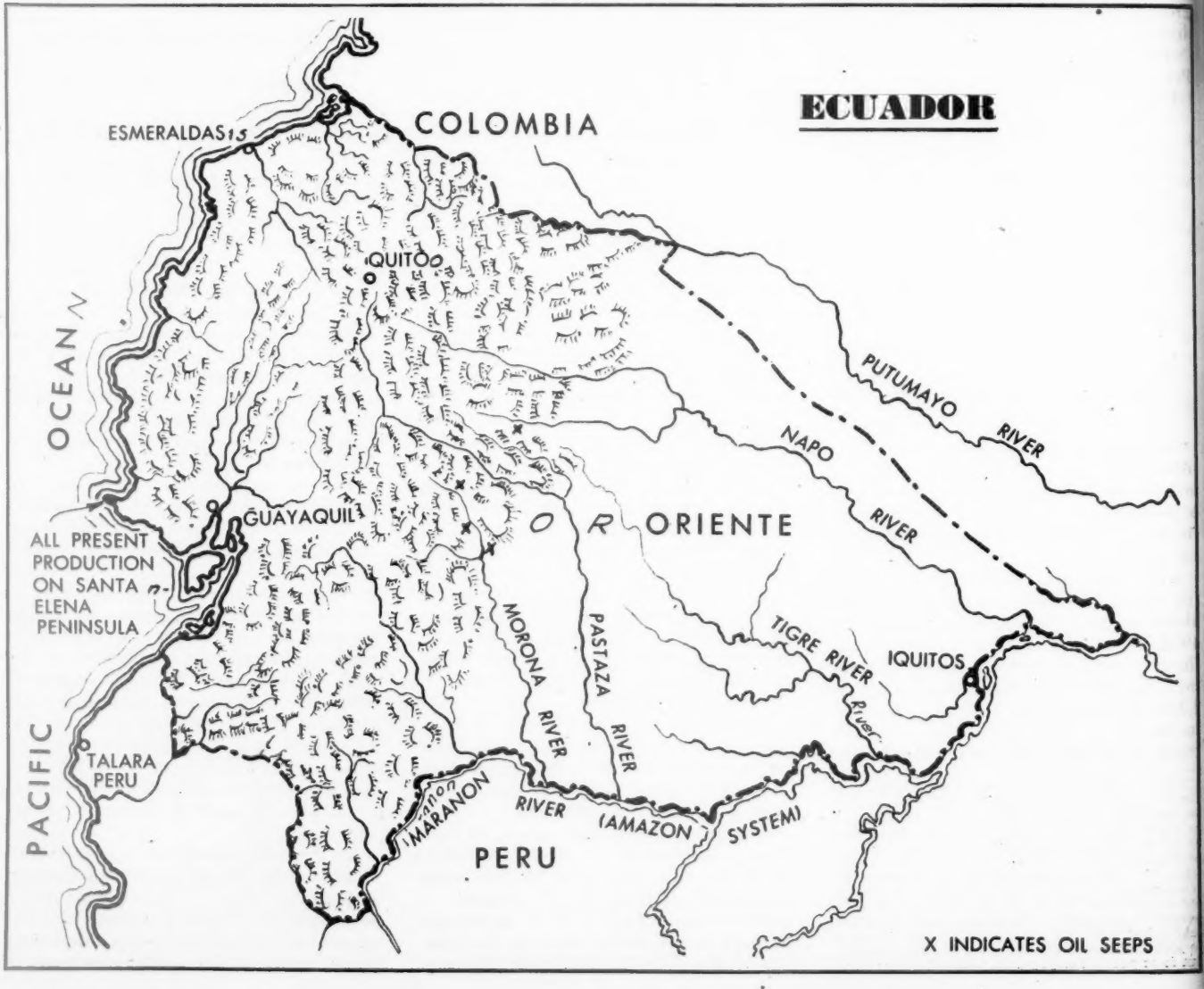
The concessionaires by denouncement shall pay an annual fee of 30.00 sucres for every oil "fundo" (4 hectares).

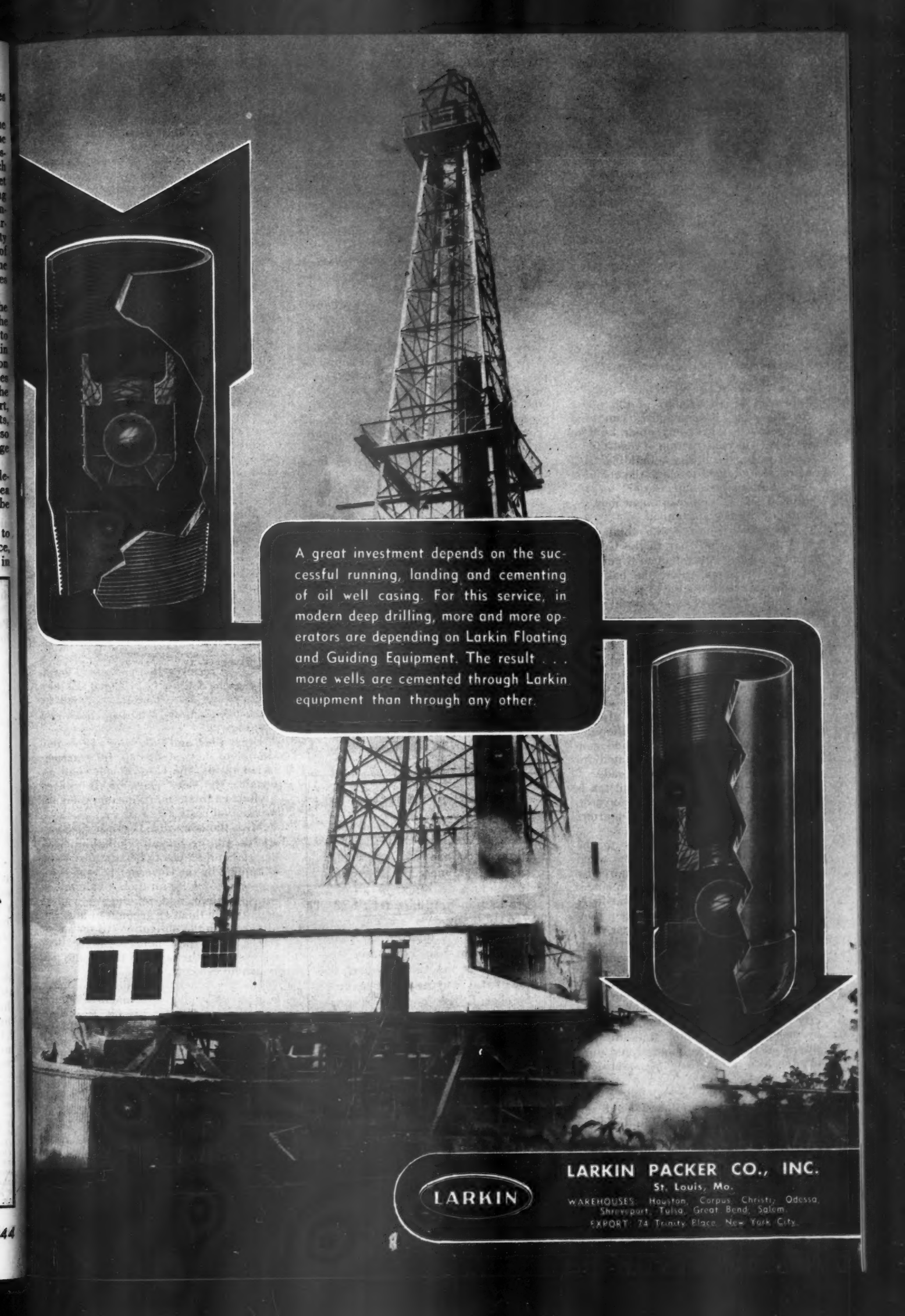
The State, as the sole owner of the subsurface wealth, is participant in the oil production obtained by every concessionaire. This share or royalty, which varies from 11 to 5 per cent of the net oil production, is computed according to the distance between the storage center of the concessionaire and the nearest shipping port, the maximum royalty of 11 per cent being applied in case of distances less than 50 kilometers, and the minimum one of 5 per cent for distances greater than 600 kilometers.

The royalties may be collected by the Government either in species on the shipping port, in money, or in drafts, to its option; or else, taking one part in species and the other one in money on the shipping port; or one part in species on the oil field storage center and the other one in money on the shipping port, or finally, only in money or in drafts, if so chosen. The Government may also demand the sharing in the oil storage center of the concession, in species.

When the oil comes from seams or deposits covered by the territorial sea waters, the rate of 11 per cent shall be lowered to 9 per cent.

The Government shall serve notice to the concessionaire 6 months in advance, if it intends collecting its royalties in




A great investment depends on the successful running, landing and cementing of oil well casing. For this service, in modern deep drilling, more and more operators are depending on Larkin Floating and Guiding Equipment. The result . . . more wells are cemented through Larkin equipment than through any other.
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money or in drafts during the next term. In no case shall the royalties to be paid by the concessionaires be less than 5,000 sucres a month in the cases of contract. or less than 500 sucres a month in the cases of denouncement.

If the Government should decide to collect the royalties in money, the price shall be settled taking into account, optionally, the following bases:

a. The average in the last quarter of the current price of fuel oil and gasoline in the world market less the transportation expenses up to the port of Guayaquil.

b. The effective cost of production on the extraction places.

c. The average of the fuel oil and gasoline prices obtained in the Ecuadorian market during the preceding quarter.

Instead of all or part of the above royalties the concessionaires can bind themselves to effect any other kind of work such as construction of roads, highways, railroads, bridges, building, etc., being also obliged to make the consruction that, as a compensation for the granted lands, the Government may demand, if deemed convenient.

The concessionaires who obtain natural gasoline, shall pay to the Government a royalty equivalent to 8 per cent of the production value, the basis for this being three times the price for crude oil. In the Oriental Region special royalties may be specified.

The producers' price for oil derivatives destined to the national market shall be fixed by the Government. This price shall not be less than their cost of production plus a reasonable profit for the concessionaire. The sales price for the national market shall also be fixed by the Government. The difference between the fixed producer's and consumer's prices shall be designated for the national system of public roads.

For pipe lines the Government tax is 5 per cent of the transportation cost, which tax shall be collected by quarters due.

The oil refineries shall pay to the state a yearly fee of 5,000 sucres when corresponding to the concessionaires by contract, and of 1000 sucres when corresponding to those by denouncement. If they correspond to neither one, they shall pay a fee of 12,000 sucres per year. The refineries of the concessionaries can only be installed on their own camps or on the shipping ports of their products.

▼ **Transportation.** Every person or company exploiting oil from national property has the right to construct and profit by one or more oil pipe lines for the service of its own exploitation and during the term thereof and its extension, if any.

In case there are concessionaires who individually do not produce enough oil to supply an oil pipe line up to the shipping port, they may associate to construct a common pipe line. The distance, pump and evaporation losses, etc., shall then be taken into account in order to determine the royalty that every concessionaire of the same pipe line must pay to the State.

Companies or enterprises not exploiting oil may also construct and profit by oil pipe lines, previously making a contract with the Government. The latter shall demand a bond of 25.00 sucres per kilometer of main pipe line, which bond shall be deposited in money in the Central Bank of Ecuador, and it shall remain deposited throughout the time of the concession.

The Government may also construct pipe lines or contract for the construction and operation of them.

The plan and layout of every pipe line shall be submitted to the approval of the Ministry of Mines. Should there be any divergency as to the existing reasons to deny this class of constructions, the point shall be settled by an expert appointed by the parties in mutual agreement.

All pipe lines constructed by non-oil companies shall be considered as public transportation utilities. Over them the government shall have a preferential right for the transportation of all its oils, according to the tariffs in force at the time of the transportation, minus a 5 per cent deduction; this preferential right of the Government shall be up to 20 per cent of the daily carrying capacity of the oil pipe line.

In agreement with the different concessionaires the Government shall determine the transportation tariffs, taking into account the amortization of the capital invested in the construction; the upkeep, administration, and exploitation expenses, and an equitable profit for the concessionaire fixed on the basis of the profits realized by similar oil pipe line companies in other countries, particularly in the South American ones.

The period of duration of every oil pipe line contract shall be 30 years, which may be extended for 10 more years by mutual agreement. At the end of said period the pipe line with all the construction, installations, and immovable properties therefor shall become the property of the State. Oil pipe lines constructed by oil concessionaires shall also pass gratuitously to the State at the end of the respective periods.

The Government shall revise the transportation tariffs for periods of four years in order to determine those that are to be in force in the following period. It shall take into consideration the concessionaire's profits; the upkeep, administration, and exploration expenses, and the unamortized capitals at the time of each revision.

▼ **Refineries.** The refining industry may freely operate in the country provided the refiners abide by all the dispositions regarding the respective taxes, which have been discussed above.

The concessionaires by contract or denouncement may have their refineries installed and in operation throughout the period of duration of the concession and any eventual extension.

Non-oil companies may ask for a refinery concession from the Government. Said concession, if granted, shall have a duration of 30 years, and a previous bond of 15,000 sucres, to be kept as a guaranty for all the duration period, shall be an indispensable requisite.

The Government shall have the power of establishing and operating refineries or of contracting for their construction or operation to treat the crude oils accruing from royalties or taxes or acquired for any other reason.

The oil received by the State as royalties may be sold by it, provided the sales price is not less than that offered by the concessionaires who contribute said royalties.

Every year, and following a procedure similar to that established for transportation tariffs, the Government shall determine the sales price of the refined products taking into consideration the production costs.

▼ **Miscellaneous dispositions.** Administrative and technical regulations shall determine the fines to be administratively applied by the Government to the concessionaires of exploration, exploitation, transportation, and refining, to impose penalties on them on account of noncompliance with the obligations of their contracts, when said noncompliance does not result in the lapse of their contracts or denouncements.

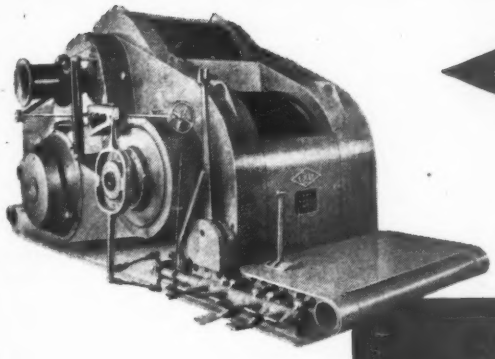
The annulment or concellation may be decreed by the Government when the prescriptions of the present law have not been complied with in regard to the surety bonds to be deposited, the capital to be invested, the operations to be carried out, the taxes and fees to be paid. Cancellation may also be declared if the existence were legally proved of hindrance to the supervision and fiscal rights on the part of the Government, or if the concessionaires transferred their concessions to foreign Governments, and also if they made the transfer to any company or person without the express authorization from the Government.

Ecuador production up

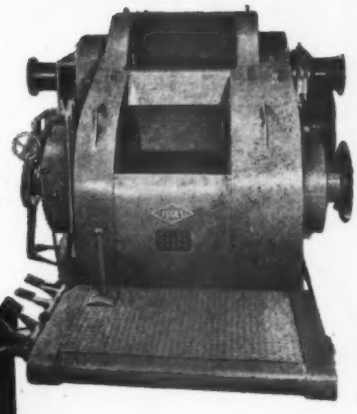
Production of crude petroleum in Ecuador has shown a slight increase over a similar period last year. For the quarter ending on March 31, 1944, production amounted to 638,916 bbl., more than was produced for any quarter last year. A large British company accounts for the greater part of the total output at present. Smaller British companies produce relatively unimportant quantities. A large British-Dutch company and a Canadian subsidiary of a United States Company are increasing their already widespread exploration activities in Ecuador. The first-mentioned company is testing in the Oriente Province, while the latter is limiting exploration to the coastal area.

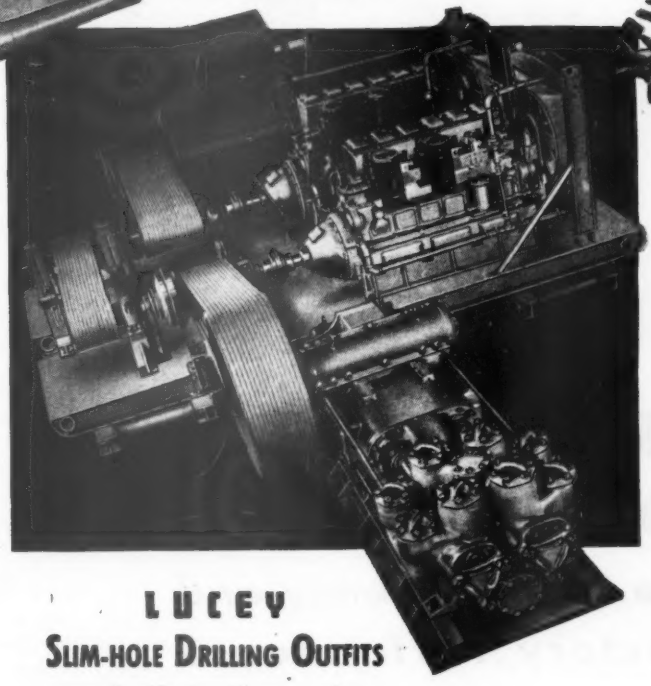
LUCEY SLIM-HOLE DRILLING OUTFITS

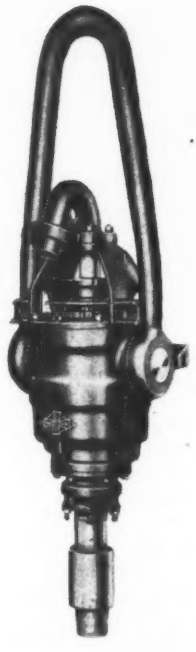
LUCEY



Illustrated is the type "ES" outfit. Photos show operating outfit with portable jacknife derrick.







LUCEY
SLIM-HOLE DRILLING OUTFITS
are built in three sizes and capacities:

TYPE "B" . . . . 2,500 FT.
TYPE "C" . . . . 5,000 FT.
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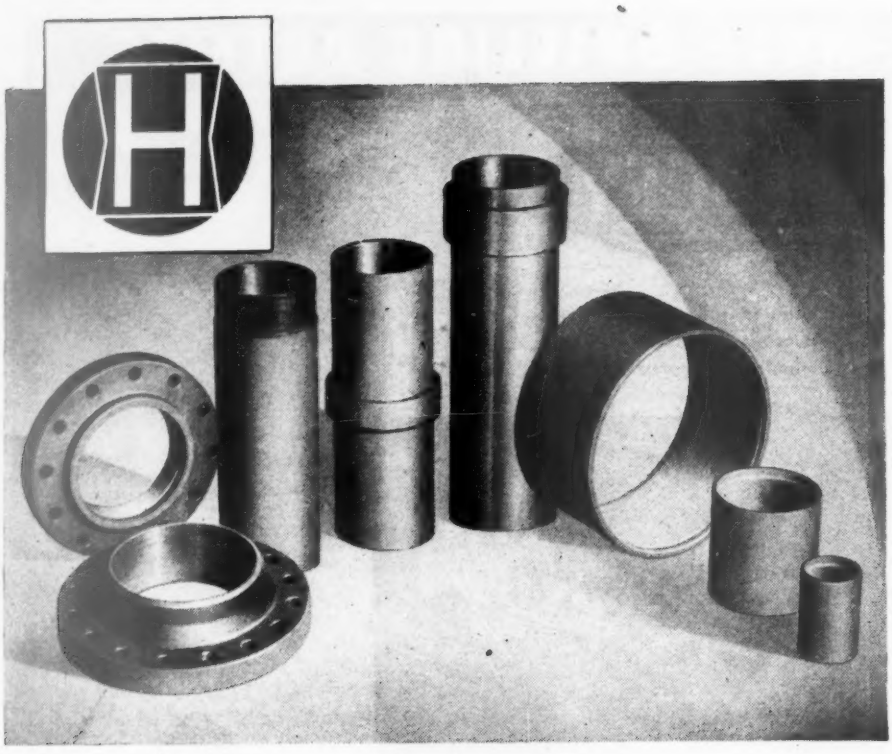

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The administrative declaration of cancellation of a permit shall not be made without previously notifying the concessionaire in question. Said notice shall give him a term of 60 days to rectify or to mend the faults he is charged with, or to formulate his defense before the Ministry Court of Mines, being able to appeal as to its decision before the Council of State or the entity replacing it in its functions.

The concessionaires of oil exploration shall have customs exemptions as well as exemptions of the taxes not expressly determined in this law, during the period granted by it for each case. The exploitation concessionaires by contract or denouncement as well as the transportation and refining concessionaires shall also have these exemptions during half of the time of granting of their concession. For the same time capital employed in the exploration, exploitation, and development of the other oil concessions is exempt from analogous taxes.

No concessionaire shall be able to sublet his concessions without the previous authorization from the Government.

All work or operations of any nature related to the oil industry must be carried out according to the dispositions to be stipulated in the Technical Regulation of Oil Operations, which, among other things, shall precisely establish the difference between exploration and exploitation.

The Government may demand from the concessionaires all the crude or refined oil deemed necessary for the state services, especially railroad transportation and national defense, according to the percentage to be established in every contract. The Government shall pay for these products a price corresponding to the effective cost of production in the places where obtained, plus the transportation expenses to point of delivery, and a percentage to be stipulated between the Government and the seller, at the moment of the purchase, contemplating a profit for the latter, according to his administration and management expenses, said price being, at all events, less than that current in the market.

The Law of Hydrocarbon Deposits of October 8, 1921, is revoked by the present law, together with all its modifications, as well as all other decrees and laws on hydrocarbons and petroluem that are opposed to the present law.

All the rights shall be respected that were acquired in conformity to former laws or special decrees on oil concessions, but the present concessionaires may claim the right to abide by the present law.

Concessionaires' legal suits shall be acted upon by the Supreme Court of Justice of Ecuador, when they are suits with the Government; but every controversy of the concessionaires between themselves on matters involving their mining rights shall be administratively decided by the Ministry Court of Mines, the decision of which shall be subject to appeal before the Council of State.

★ ★ ★

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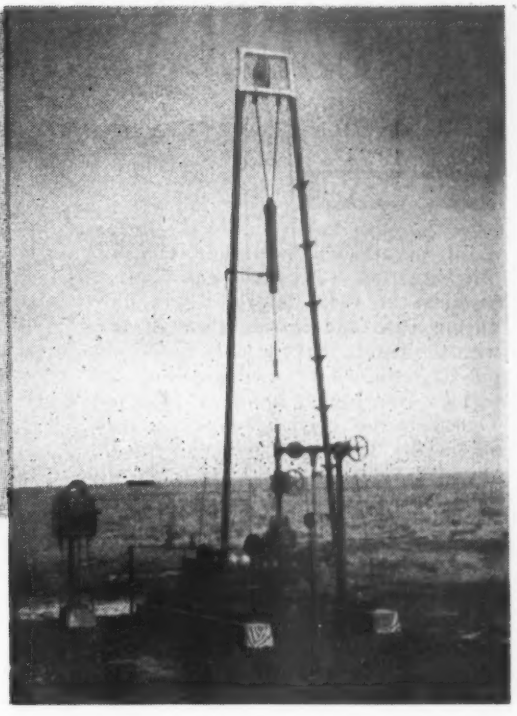

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VENEZUELA MOVES AHEAD

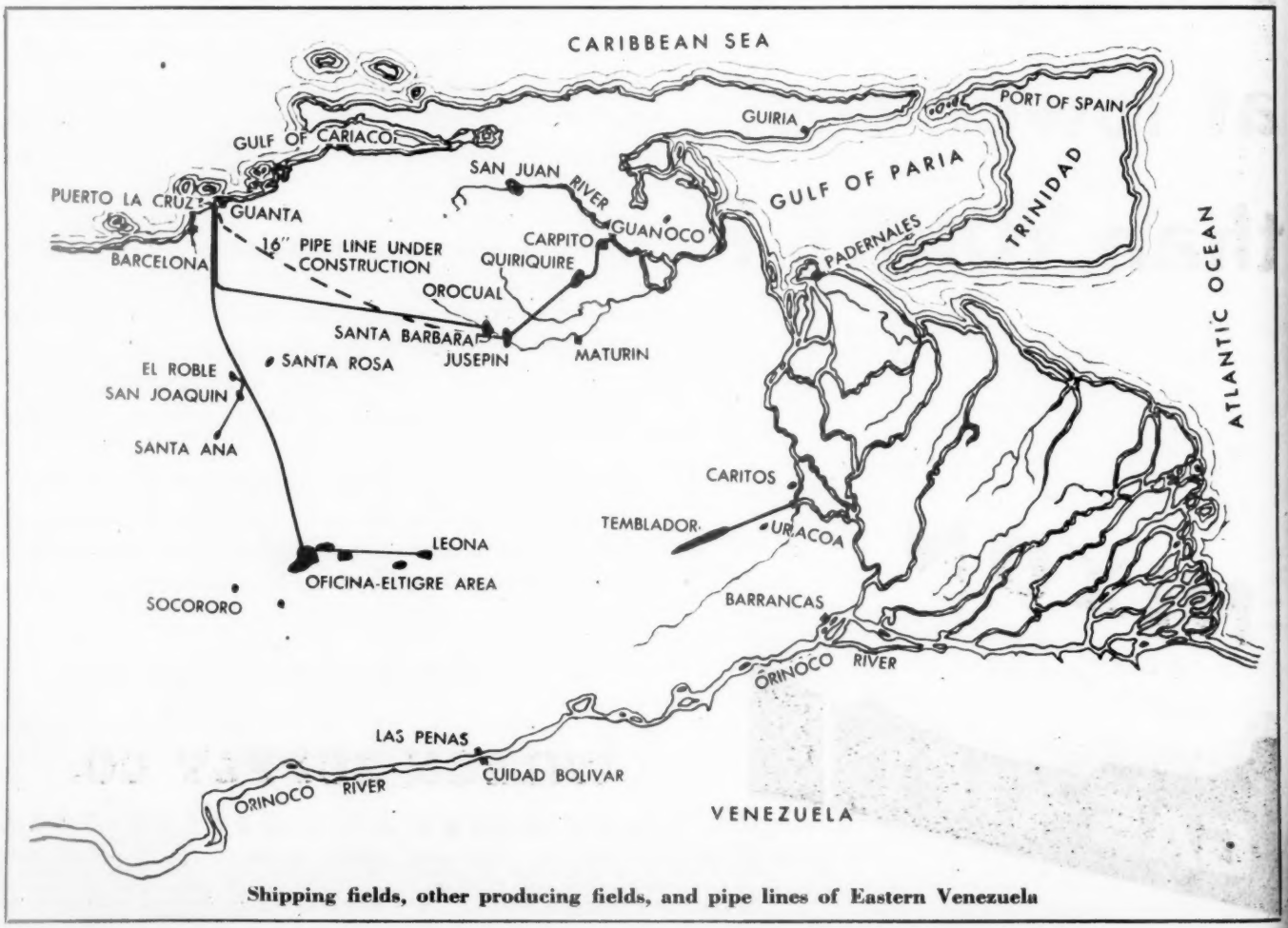
EXCLUSIVE In many respects the period 1943-44 has been the most important in the history of oil operations in Venezuela. The shipping situation, which had been a serious problem in 1942, improved gradually during 1943 and further through 1944, with the result that the nation's oil output has attained record high levels and will go even higher before 1944 is out. Venezuela has been a major source of oil for the Allied war machine and the operators there have worked closely with the U. S. Petroleum Administration for War to boost output steadily in line with the increasing military demand. The PAW schedule for Venezuela assumes a 1,000,000 bbl. per day output by the end of 1944; by August the country had attained a mark of over 800,000 bbl. daily; although the program may not be fully realized due to equipment and transportation shortages it is probable that there will be some further increase.

Most of the increased output has come from intensive development of existing fields, there having been no major discoveries brought into production during the war period. The drain on proved reserves means that increased exploration activity must be undertaken as soon as feasible, and although the manpower and equipment troubles may serve to hold down exploration work temporarily it is certain that relief on these problems will see very intensive activity shortly thereafter. Even now, several promising oil areas not hitherto developed are under study by most of the established operators as well as some newcomers to the Venezuelan oil picture.

A major development in 1943, one greatly affecting future oil activity in Venezuela, was the enactment of a new petroleum law which has been widely hailed as well-balanced and fair to both private operators and the government. While increasing the tax and royalty payments by the operators, the new law eliminates older rules regarded as hindering exploratory activity and provides a stable, mutually satisfactory basis on which future development may be planned. One marked result will be the acceleration of refinery construction within the country and virtually all operators have formulated plans for early construction as soon as obstacles imposed by the war will permit.

There have been no major changes in drilling technique or completion practices in Venezuela over the past two years, aside from the initiation by Creole of a new type of twin well foundation for their deep water drilling in Lake Maracaibo. Due to the shortage of both drilling and well completion equipment and supplies, the principal problem faced by the operators has been the search for substitute materials, salvaging, reconditioning, etc., much as has been the case with operators in the United States.

The principal producing companies in Venezuela have been the Creole Petroleum Corporation, an affiliate of the Standard Oil Company (N.J.), producing slightly more than half the total output; various subsidiaries of the Royal Dutch Shell group, with about one-third the total production, and the Mene Grande Oil Company, a subsidiary of Gulf Oil Corporation, producing about 10 per cent. Other companies have been represented for many years in Venezuela, but it has not been until recent years that large scale activity by these has come about. Among other American oil concerns that have recently been active in the Venezuelan picture have been Socony-Vacuum, The Texas Company, and Sinclair, which have already developed substantial production at Santa Barbara in Eastern Venezuela and has built a pipe line from there to Puerto La Cruz on the Caribbean coast. The two first mentioned are at present notably active in exploration work. Recently also a number of newcomers to the Venezuelan scene have been noted, including a number of North American oil com-



Shipping fields, other producing fields, and pipe lines of Eastern Venezuela

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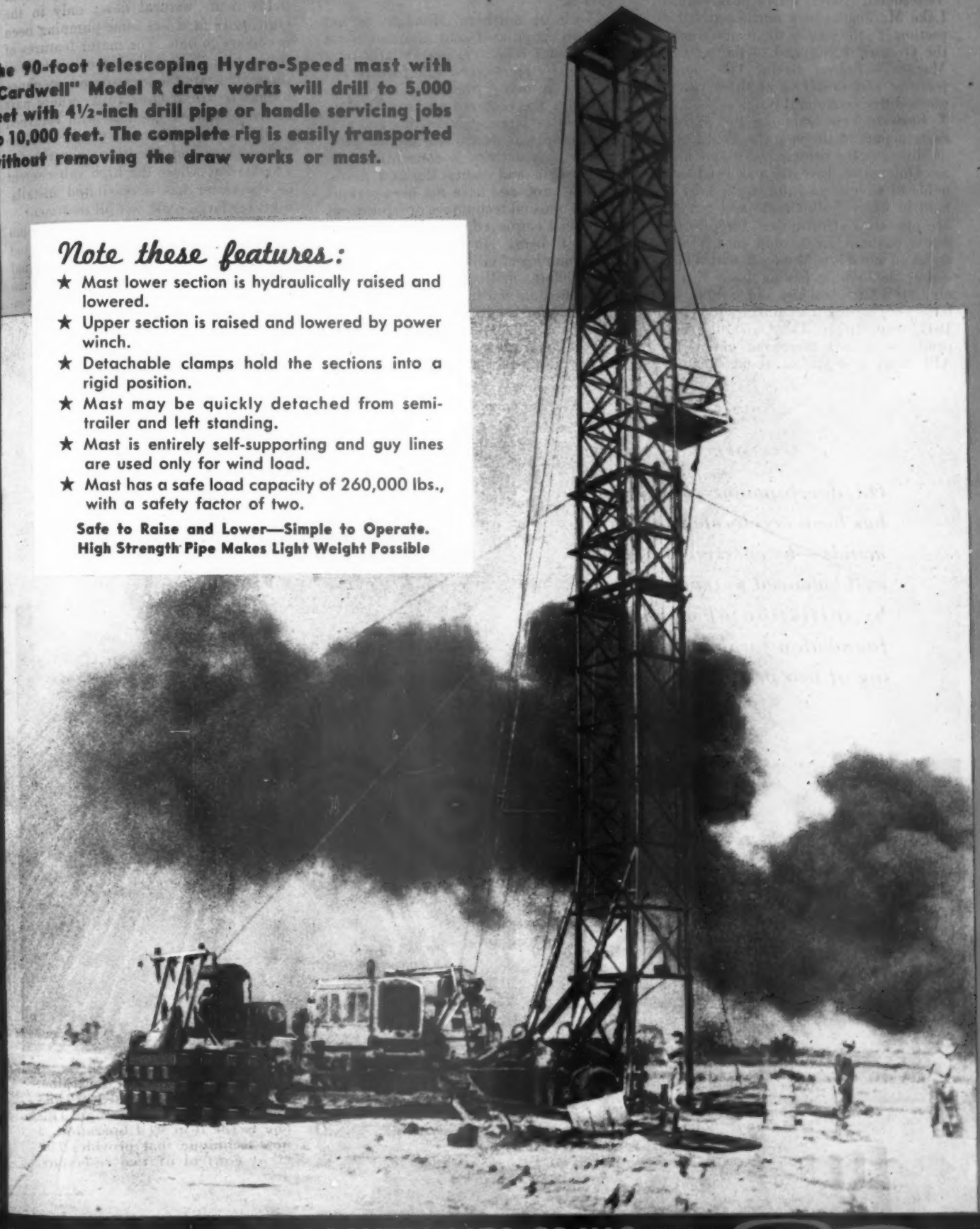

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panies whose new foreign activity has been attributed by some to the recent decrease in oil-finding success at home.

From an oil standpoint Venezuela is divided into two major areas by the Venezuelan Andes, which pass south of Lake Maracaibo in a northeastward direction. To the east of the mountains lies the Orinoco Basin and to the west the Maracaibo-Falcon Basin. The general features and problems of these two regions differ considerably.

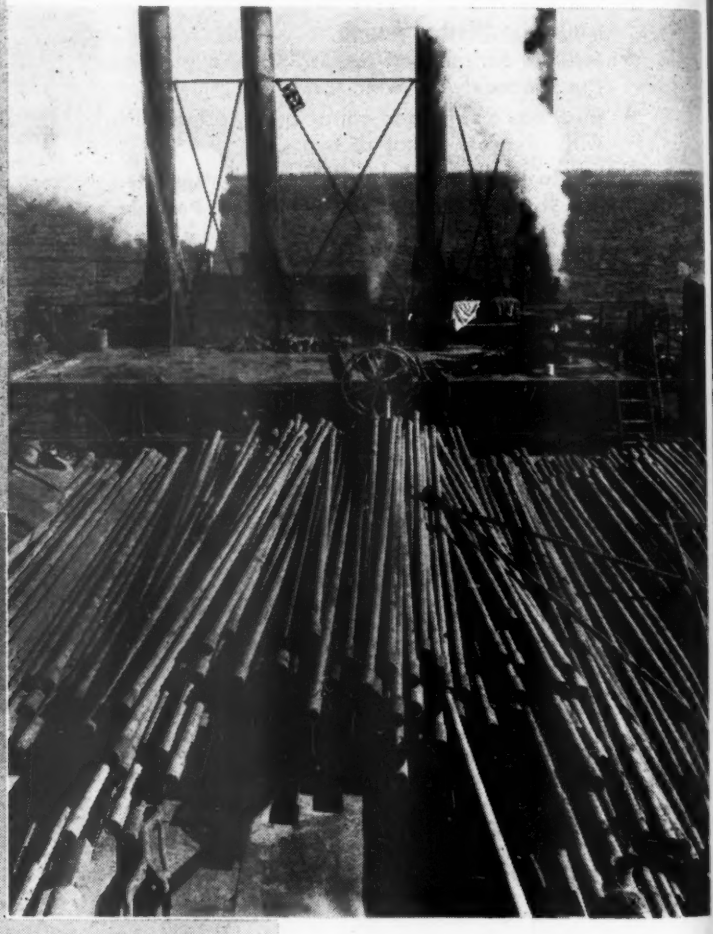
▼ **Eastern Venezuela.** In the extreme eastern part of the country, in the state of Monagas, the principal shipping fields are Quiriquire, Jusepin, and Temblador fields of Creole, and the Santa Barbara field in which both Creole and Sinclair are operating. Quiriquire, Jusepin, and Santa Barbara are located on a NE-SW trend in northern Monagas with Quiriquire, the oldest, having been discovered in 1928; Jusepin and Santa Barbara were brought in during 1938 and 1941, respectively. The Quiriquire field produces an oil averaging about 19° API from a depth of about 3000 ft., while both the others produce oil of about 33° API from a depth of 4000 ft. to 5000 ft. Temblador, in the southern part of Monagas, was discovered in 1936 and produces 21° API oil from about 3500 ft.

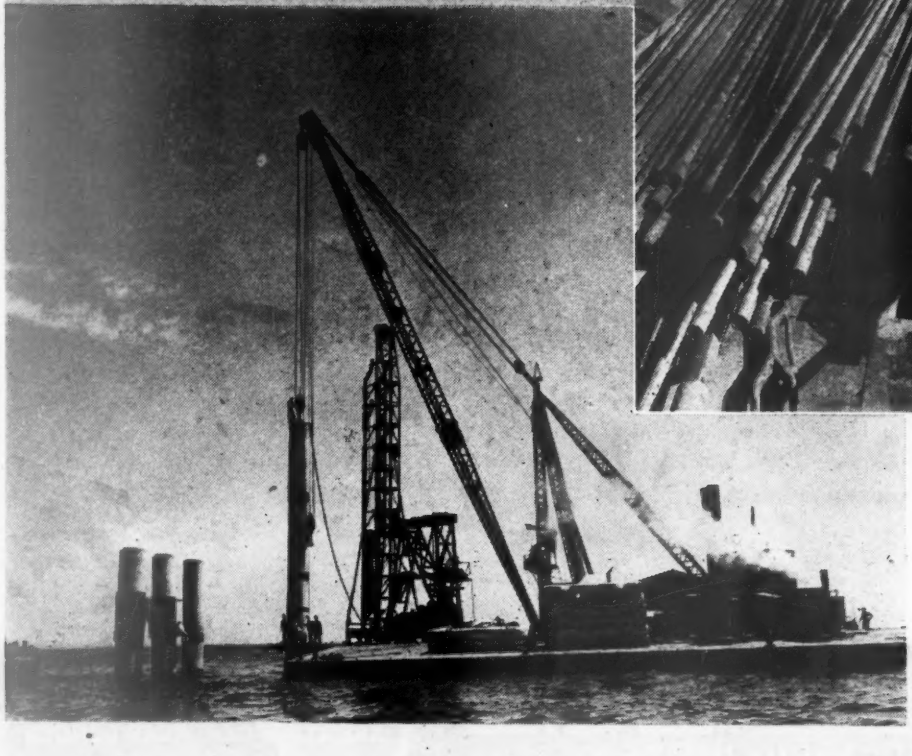
Much of northern Monagas is but sparsely populated and contains some thick jungle country, particularly near the many streams, and this feature has introduced many problems in connection with the required surface development before large scale drilling and production operations are feasible. At present, drilling activity is concentrated in the Jusepin and Santa Barbara fields. Drilling problems have not been serious and no unusual techniques or equipment have been employed, the rigs, all steam powered, being similar to those commonly employed in the U. S. for normal 5000-6000-ft. drilling. The formations are of medium hardness. Both drag and rock bits are used; rate of penetration is good and bit service fairly high. There are two major oil zones in both the Jusepin and Santa Barbara fields and a dual completion technique, in which a packer is set between zones, was being employed prior to the equipment shortage brought on by the war.

Most of the production from these four fields is by natural flow; only in the Quiriquire field has some pumping been necessary to date. The major features of interest in the producing operations of these fields are the pressure maintenance by gas return at Quiriquire, where part of the produced gas has been returned to the sand for several years, and the dehydrating and desalting operations at Temblador, where the high salt content of the water has necessitated installations for large scale wet oil treatment.

Oil from the Quiriquire and Jusepin fields is moved eastward by 10-in. and 8-in. pipe lines to Creole's terminal and refinery at Caripito on the San Juan River leading to the Gulf of Paria. Sinclair's Santa Barbara oil moves westward to Puerto La Cruz on the Caribbean through a 12-in. pipe line. Creole is currently constructing a 16-in. line

Oil development in Venezuela has been accelerated by war demands—by enactment of a new, well-balanced petroleum law—by initiation of a twin well foundation for deep water drilling of two productive horizons.





Drilling barge in Lake Maracaibo. Two pile drivers are used in sinking caisson at proper location. This one is for twin well operation, a new technique that provides efficient control of two reservoirs.

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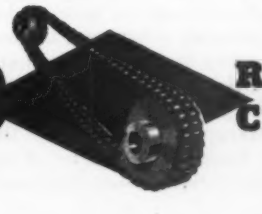

DIAMOND ROLLER CHAINS

from Jusepin to Puerto La Cruz, the completion of which is expected by late 1944. Temblador crude goes by pipe line to a terminal at Boca de Uracoa on the Manamo River, thence by shuttle tanker to a deep sea terminal at Guiria on the north shore of the Gulf of Paria.

In the state of Anzoategui, next west from Monagas, there has been rapid and intensive development since the first major discovery of the area, the Oficina field, in 1937. This field, about 100 miles inland from the Caribbean coast, was followed in succeeding years by the discovery of a number of other pools in the area, among the most important of which are San Joaquin, Leona, Santa Ana, and El Roble. All these fields have generally similar subsurface features and are marked by multiple producing sands, in some instances the sands showing a range of oil gravity of from 15° to 50° API. Not all heavier oil is being produced, however, and average gravity of the oil produced in the area is about 35° API. Producing depth ranges from about 5000 ft. to 10,000 ft. subsurface and the oil in some reservoirs is in the vapor phase.

There have been many drilling problems in this area, most of which have stemmed from unusually high subsurface pressures and temperatures, the latter being as high as 275°F. in the deeper wells, coupled with the hardness and poor mud-making qualities of the strata penetrated. The drilling rigs commonly used are steam-powered and employ heavy equipment; 136-ft. derricks, four 125 hp. high pressure boilers, two 20-in. slush pumps, 300-ton hooks, etc., are common. All equipment is unitized and skid mounted, and in developed areas rig moves are made in about 5 hr.

The Anzoategui fields are served by a 16-in. pipe line, which runs from Oficina to the coast at Puerto La Cruz, where there is a deep sea terminal.

The most important recent development in existing fields of Eastern Venezuela was the discovery in early 1944 of prolific production in a new deep sand at Jusepin. No detailed reports on the extent of the new horizon have been made but there has been some evidence to indicate that the development may open a large new reserve in Jusepin proper. Further, the sand will henceforth be marked as a potential oil zone throughout the area and the zone may prove production elsewhere along the Quiriquire-Jusepin trend.

In the postwar period, Eastern Venezuela should continue to prove a fertile hunting ground for the oil operators, for large areas of favorable land remain but little tested. Although continuing work may be looked for in the state of Monagas and Anzoategui, the major oil regions so far, there is already evident considerable interest and activity in new areas. The state of Guarico, west of Anzoategui and directly south of Caracas, is already the scene of much preliminary exploratory work by several operators. Similarly, the Apure River area, southeast of Lake Maracaibo but a part of the great Orinoco Basin, is the scene of active exploration at the present time and,

Three scenes from operations in Eastern Venezuela. Top shows mud pits at a well being drilled in Jusepin field. Center is a core drilling crew with Cardwell equipment in the Quiriquire field. Bottom scene is also in the Quiriquire field. Men are setting up boilers to drill a new well in jungle country.

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as a large and almost untouched oil province, may be expected to receive increased attention after the war.

▼ **Western Venezuela.** While there are a number of producing fields in Western Venezuela, ranging from the small Cumarebo field on the north coast in the state of Falcon, a field in which almost complete pressure maintenance by gas return has been practiced by Creole Petroleum Corporation, to fields near the Colombian border, the major reserves of the area and the features of greatest interest from an operating standpoint are in the Bolivar coastal fields on the eastern shore of Lake Maracaibo. These fields extend along the shore of the lake for some 50 miles and large portions of the productive acreage are under water. The land concessions along the shore are owned by Venezuelan Oil Concessions, a unit of the Royal Dutch Shell group. A series of narrow strips of water acreage following the shore line is owned by the Mene Grande Oil Company (Gulf), and an extensive area of water acreage extending several miles off shore is owned by Creole. The operations on the land have been conducted with conventional techniques but the over-water operations have posed problems not faced by any other oil operation in the world.

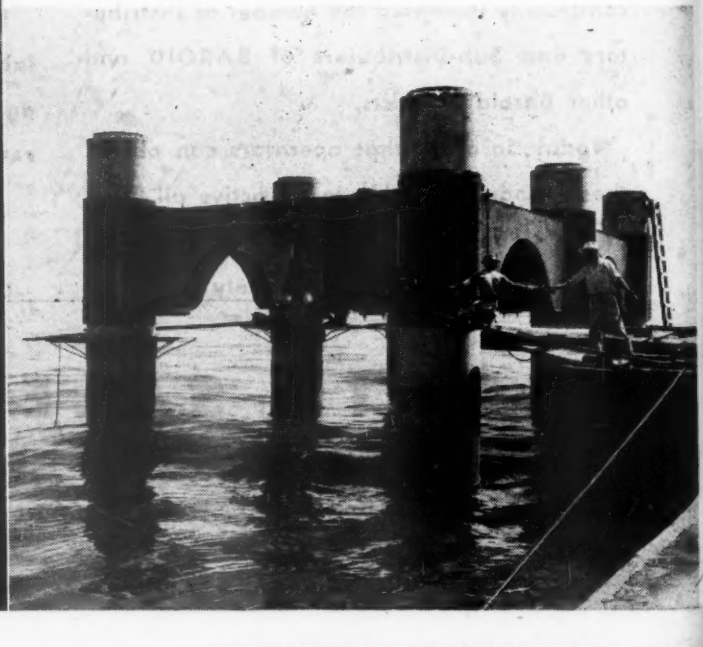
Except in the close inshore areas, the water depth is too great to permit the use of conventional wooden piling for foundations and many unique practices have been developed to permit operations in water depths of more than 80 ft. and at distances that to date have reached 8 to 10 miles from land. The productive sand in these fields dips lakeward and current producing depth ranges from about 1000 ft. in the certain areas along the shore to over 5000 ft. in the downdip areas under the lake. Oil gravity varies from about 12° API, the lighter oil usually found in the downdip area.

The equipment for the first lake wells, drilled in shallow water, was supported by land type concrete pedestals or by timber mats, and operations were identical with those on land. Production was extended into 10 or 15 ft. of water by substituting wooden piles for the pedestals, but it was soon evident that specialized foundations and equipment would have to be developed for the economic exploitation of deeper water extension of the fields.

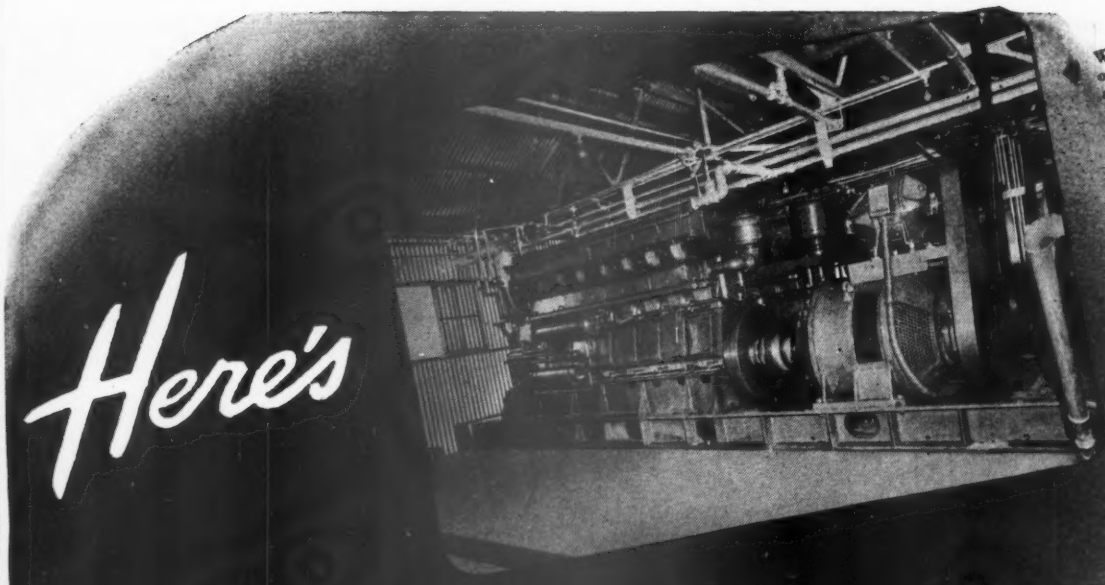
For water depth down to 60 ft., precast monolithic concrete piles were selected because they are not attacked by either the wood eating teredos or by the very corrosive lake water, and because they could be built in any size to suit a variety of structures and foundation conditions. With the exception of such special types as sheet piles, precast piles from 12 in. to 24 in. square and up to 133 ft. long are used. Extensions are occasionally cast on the piles to a total length of 145 ft.

With these piles, which are placed by a pile driver barge, derrick foundations usually consist of two plumb and one batter or brace piles in each corner, a total of 12 piles per well. A concrete cap, cast in place in each corner, ties the three piles together and to the structural steel derrick base, to make a rigid structure. The base is 24 ft. square with a 15-ft. cantilever overhang on one side and 10 ft. on another, and carries all loads to the corner piles. It supports the engine, drawworks, rotary, landing platform, 122 ft. derrick, and auxiliary drilling machinery. During drilling operations the drawworks, drilling engine, and engine house are placed on one of the cantilevers and a small wire line hoist and steam engine for pulling a wire line core barrel or for swabbing, is placed on the other. Later when the well is placed on the pump, the pumping unit is placed on one cantilever leaving the other for a clean-out hoist. The same weight of base is used for all wells within fixed depth limits. To determine the length of piles necessary, a test is driven at each location and the foundation piles are cast exactly to fit the site.

For water depths of over 60 ft., a completely new type of support had to be developed and the result was a caisson type foundation. It consists of four concrete encased, steel core, composite hollow cylinders, 5 ft. or more in outside diameter and having a wall thickness of about 6 in., connected above water by welded steel arch girders to form a rigid frame. The caisson is fabricated on land and at least partially assembled in the yard by joining several 15-ft. lengths, and the assembled portion is then moved by barge to the location where it is up-ended by derrick barges and set in place. The caisson piles are not driven, as are the solid piles, but are forced to the desired depth in the lake bottom by the imposition of 200 tons of dead weight in the form of concrete blocks placed on top of the pile after it has been lifted into position, filled with water, and allowed to sink of its own weight as far as it will go. Additional sections are added, one by one, as the top of the assembled portion approaches the surface of the lake. The longest cylinders used so far are about 185 ft. in length and weigh about 100 tons. The caisson foundation is similar to the older pile type only in that it uses



Both the jungle and the sea of Venezuela yield oil. Each requires its own type of equipment and method. Left, an oil well rises from the thick, tangled jungle. Below men are working on a twin well foundation, consisting of the regular 24-ft. base, 4-caisson layout and, in addition, a 21-ft. extension base and 2 caissons to give a rectangle platform.



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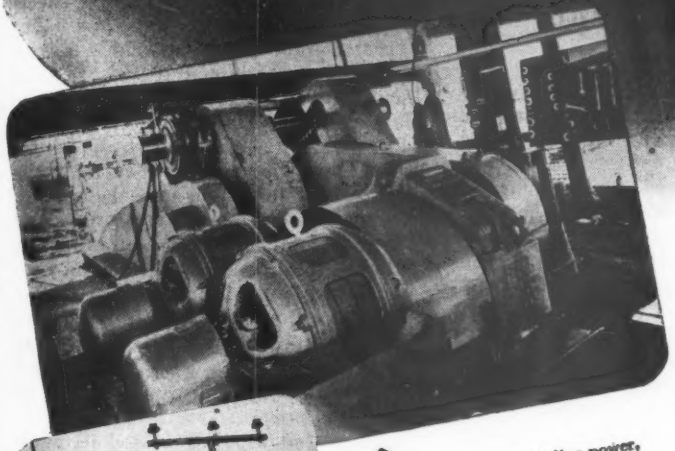

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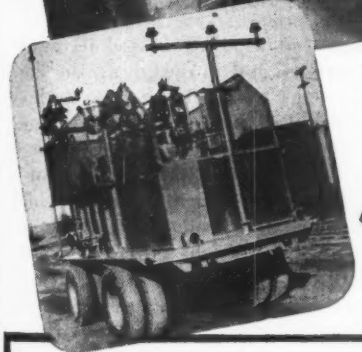

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Electrical Equipment for the Petroleum Industry

the same derrick base supported at the four corners. Fundamentally, the two designs differ radically because the pile type depends upon brace piles for lateral strength whereas the caisson type is a true rigid frame without braces.

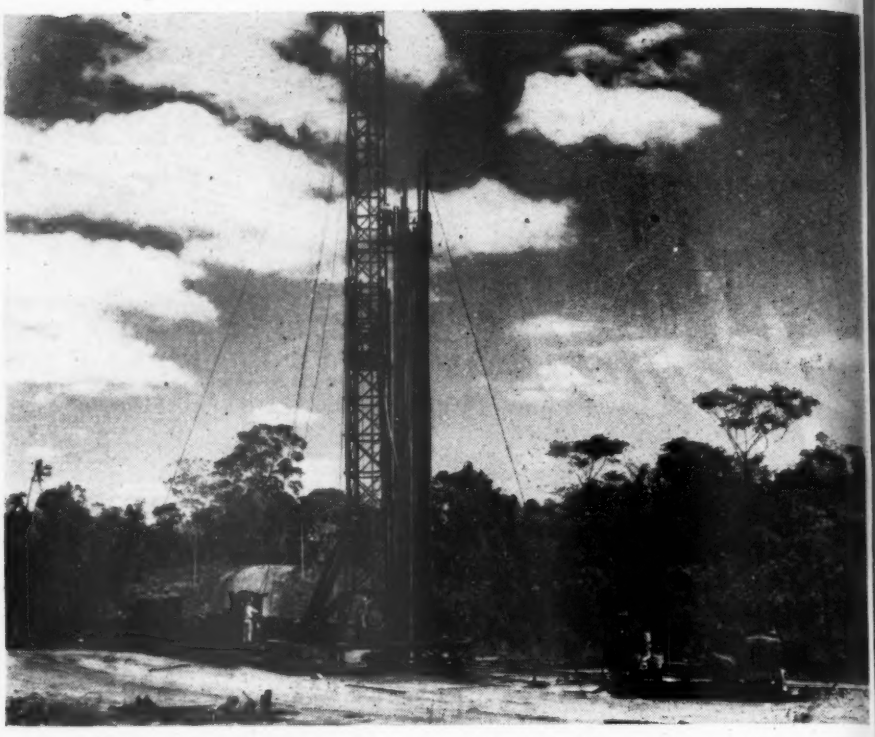
In drilling with either type of foundation the power plant, pipe racks, mud pumps, and pits are mounted on a drilling barge, which is anchored adjacent to the derrick foundation. The present drilling barges are 110 by 48 by 8 ft. and are equipped with three to four 125 hp. oil field boilers, two 18-in. or 20-in. mud pumps, fuel compartment holding 225 bbl. of fuel oil, mud circulating system and pit, pipe rack, and anchor hoists. Mud, water, and steam lines are connected to the rig from the barge by means of flexible connections. Auxiliary barges consist of a cementing barge, mud barge, fuel barge, and production test barges as well as dumb barges for transporting equipment.

The latest variation to be introduced by Creole engineers is the twin well foundation on caisson piling for deep water drilling where two separate horizons are productive and it is desired to use the twin well technique to provide efficient control of the two reservoirs. Several such twin well locations are on the Creole 1944 program. The new foundation consists of the regular 24-ft. base, 4-caisson layout, with the addition of a 21-ft. extension base, and two more caissons to give a rectangular platform on 6 caissons. The first of the twin wells is drilled as usual; then the derrick and drilling equipment is skidded along the rectangular base to a new position and the second well is drilled.

Consideration has also been given to the use of a multiple well foundation and directional drilling, by means of which several wells could be drilled from one foundation in order to save the very substantial expense of deep water foundations for separate wells. The latter problem may become greater if operations are extended further over the lake.

The course of future activity in the Lake Maracaibo area, as in other portions of Western Venezuela, may be expected to be in the direction of both wider exploration to test the large favorable areas as yet undeveloped and also towards deeper zones in existing fields. In recent years the development of prolific production from deeper sands has been a characteristic of the Maracaibo region and there have been no suggestions that the limit has been reached; in fact, future developments along this line are believed by some observers to hold great promise.

The favorable results of Creole's work in extending production farther and farther from the eastern shore of Lake Maracaibo has created renewed interest in the western waters of the lake and also in the central mid-lake portions. Large areas of the lake remain open for concessions and several operators have been reported as interested in bidding on the prospect despite the hazards and costs of the over-water operation. Whether the successful bidder will follow the general techniques developed so successfully by Creole or will bring out an entirely new system will be a point of interest for the future.



Cleaning out a well in the Quiriquire field.

Creole's gathering stations, compressor plants, absorption plants, permanent boiler stations, and high tension transmission lines have all been built on the monolithic concrete pile foundations, the deeper water caisson type not yet having been required for these units. Each foundation is designed for the equipment it is to support, and may vary from light concrete pile caps supporting steel beams and a wooden deck for gathering stations to massive monolithic concrete decks for vibrating machinery, such as 600 hp. compressors.

All flow stations are equipped with automatic float switches that start the station-to-shore pumps when the oil reaches a height of 6 ft. above the suction and cut them off at 1 ft. above the suction. Although the tanks are capable of holding 24 ft. of oil, they are kept pumped down so that in case of a power interruption there will be ample space in the tanks to receive the production when producing wells are being closed in. The crude oil from the flow stations is received and fiscalized at four shore tank farms located at Lagunillas, La Salina, Rio Ule, and Punta Gorda. The first two of these, Lagunillas and La Salina, are also lake tanker loading terminals; Rio Ule and Punta Gorda are merely receiving and transfer points.

One of the phases of the lake operations that is considerably different from the corresponding work on land is the laying and maintenance of pipe lines in the lake. Welded lines laid in the lake to date include all the standard sizes of line pipe from 3 in. to 12 in. inclusive. Before any joint is ready for installation it is first treated with a coating of enamel in the pipe-treating plant at La Salina. Treated joints are then welded together in lengths approximately 95 ft. long and sent out on the lake to a special pipe-laying barge. These barges, 110 ft. by 40 ft. by 7 ft. have been equipped with pipe racks and special gear for letting the welded line slide into the water at the stern as the barge is drawn ahead. As each joint is welded to the line it is allowed to slip partially into the water and a new joint is moved into position and welded onto the line. In the deepest water it is necessary to give the pipe additional support by using empty 50-gal. oil-drum buoys to prevent sharp bending of the pipe.

All gas-oil separation is done at the flow stations, and in designing the lines the problems are much the same as those encountered in the design of shore lines. One problem peculiar to the lake is posed by existence in the water of a small marine animal, the teredo, which eats through the protective coating, exposing the pipe to the corrosive waters of the lake. In laying the lines, it is of utmost importance that they do not cross any more than is absolutely necessary, as crossings complicate the work of picking lines up for repairs or salvage. Minor leaks can sometimes be repaired by clamps placed on the lines by helmeted divers, but for any major break the line must be fished up and repaired on the barge.

To operate and maintain this complex system of over-water operations has required the installation of extensive facilities ashore where are located power plants, pile-casting yards, well equipped marine repair and construction yards, and completely equipped machine shops. A large fleet of speed boats, launches, tugs, and barges of various types and sizes is, of course, a necessity for all transportation is over water. ★★★

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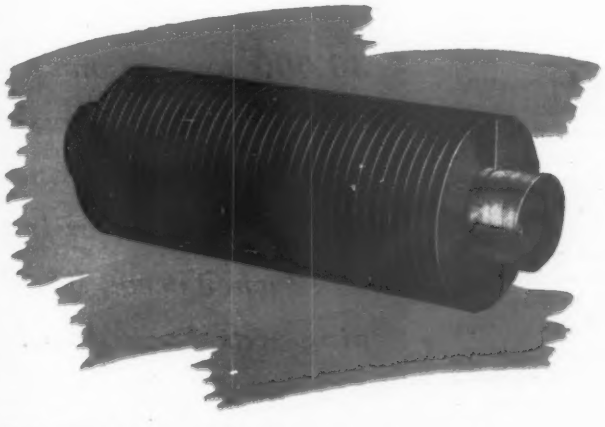

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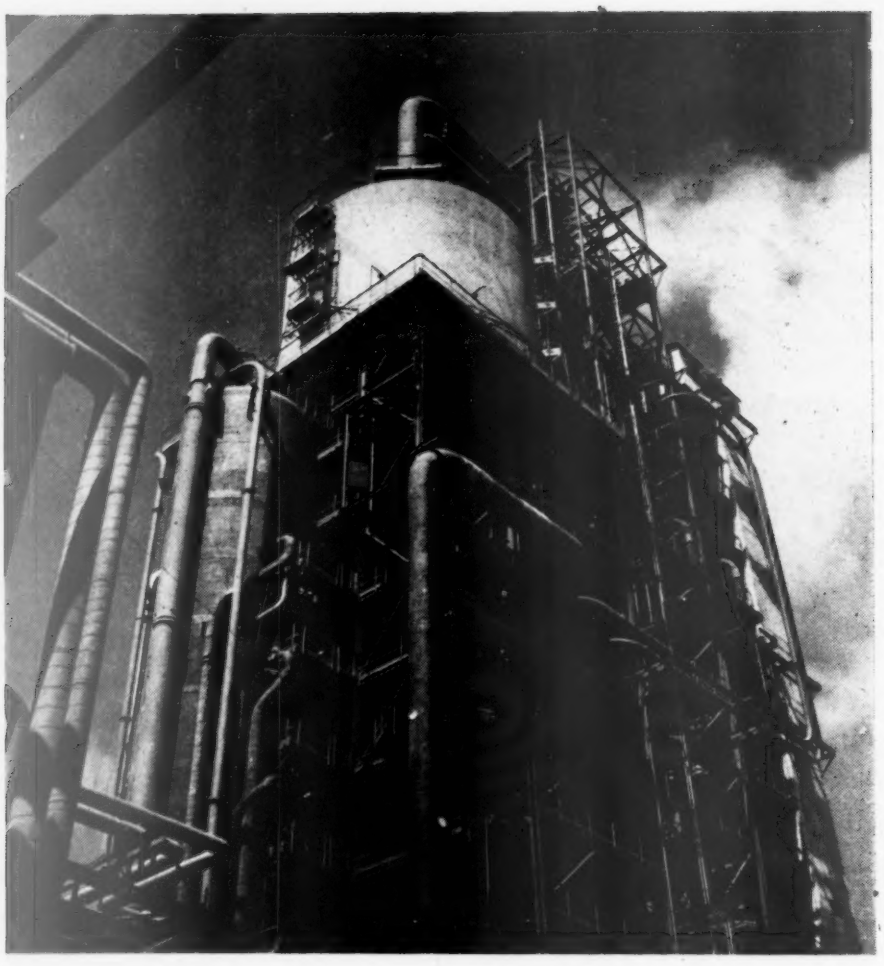

Close-up of catalytic cracker, Aruba refinery. *(Standard Oil, N. J., photo.)*

CATALYTIC CRACKING UNIT AT ARUBA HELPS MEET WAR NEEDS

By **W. W. DAMM,** Standard Oil Company (N. J.)
Foreign Refining Department

EXCLUSIVE UNDER the stress of war the Aruba refinery of the Lago Oil and Transport Company, a subsidiary of the Standard Oil Company (New Jersey), succeeded in erecting a fluid catalyst cracking unit in record time, in carrying out an initial run of record duration, and in completing the first turn-around of the unit in less time than had been necessary for any other units of the same type.

The need for 100-octane aviation gasoline increased steadily from the start of the war. Even before the attack on Pearl Harbor, demands for the gasoline from Aruba made it apparent that a catalytic cracking unit would be desirable, and by the first of 1942 plans were started for the construction of a fluid catalyst cracking unit together with an alkylation plant and associated facilities. Design and construction of the cracking unit was by The M. W. Kellogg Company, and of the other facilities was shared between the Aruba refinery, the Standard Oil Development Company, C. F. Braun and Company, Chicago Bridge and Iron Company, The M. W. Kellogg Company, and J. G. White Company.

The first problem on the construction project was the transportation of some 35,000 tons of material to the island. This transportation had to be made at a time when ocean shipping in the Caribbean was particularly hazardous. Material was ready for initial shipments from the United States to Aruba early in 1942. A preliminary cargo of such items as lumber and cement for construction of the housing and foundations, attacked by the enemy, never reached its destination. Although the amount of material was not large, its loss caused a substantial delay in beginning the construction work.

Arrangements were then made with the navy to assure more successful transportation of the material. Full cargoes for shipment were collected and through the cooperation of the navy, freighters, some of them brand new, were assigned to the work, the larger ones being of 8500-ton capacity. By operating in convoy under the protection of the navy the shipments reached Aruba without a loss. Besides freighters, much material was also carried by tankers, and a considerable amount of special smaller items of equipment was flown to Aruba by air. Having to transport the construction material over long distances both by land freight and by sea necessitated fabricating much of it within the limits of handling ability. Large equipment such as towers had to be designed to fit the transportation means. Catalyst for the cracking unit was shipped in fiber drums, some 500 tons being stored at the refinery until the catalyst hoppers at the unit were ready to be filled.

The construction project required a large force of men. Contractors supplied 400 men to supervise the construction, all of whom were flown to the island from the United States. Some replacements also were necessary to fill positions left by men who requested to be relieved. Aruba picked up labor from adjoining islands, most of the labor coming from the island of St. Vincent. Recruiting programs were organized in the various islands and the men transported to Aruba by schooners and other small boats. Eventually as many as 2600 men were brought to Aruba, a considerable number of whom were rejected for physical or other unfitness, the largest number engaged on the construction at any one time being about 2100. These were housed in a camp set up by the refinery on Aruba. Construction on some of the facilities such as the alkylation unit began while material was still being transported to the island, although construction on the cracking unit did not begin until January, 1943.

The work of construction was pressed as much as possible. The work week consisted of six or seven 10-hr. days and work was done at night whenever it could be arranged. Owing to the blackout conditions, however, little work could be done at night for the greater part of the construction period. By special permission some of the construction could be done under conditions of illumination at night where the lights were not visible in the direction of the sea.

The catalytic cracking unit first went

(Continued on Page 146)

35,000 tons of material had to be transported to island from the United States in 1942 when ocean shipping was hazardous.

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(Continued from Page 142)

on stream on December 5, 1943, less than 12 months after the start of the work. In order to save shipping space as well as the time that would have been consumed in a trial run, the unit was charged directly with synthetic catalyst for the initial run, although it had been the practice with other units to make preliminary runs on natural catalyst to determine the operability of the units. The initial run of the Aruba unit gave no unusual troubles and continued successfully at almost exactly 100 per cent of design capacity for 4386 hr., or just 6 months. This represents the longest initial run of any of the fluid catalyst cracking units. On June 5, 1944, the run was terminated according to plan for routine general inspection.

Inspection of the unit followed the procedure employed on other units. The large vessels such as the reactor, regenerator, and fractionating tower were examined, as well as the various lines and accessory equipment. Repairs to damaged parts were made when possible, or new parts installed when necessary.

The general inspection was completed on June 21, 1944, in the surprisingly low turn-around time of 16 days—less time than had been necessary on the turn-around of any other fluid catalyst cracking unit of this type. Prior to the turn-around, all the materials necessary or anticipated to be necessary replacements were collected at the site, and representatives of special suppliers and company technical men were brought to Aruba. For the inspection, 3 representatives of the suppliers, 2 from Standard Oil Development Company, and 2 from the Standard Oil domestic refinery metal inspectors' group were present. The turn-around itself was carried out by Aruba's regular staff of employees, and at times as many as 500 men worked on the unit in a single 24-hr. period. Man-hours required for the turn-around totaled 61.567, of which some 16.000 man-hours represented overtime. Despite the lost-time injury having been sustained on the unit.

Two years after the entrance of the United States into the war catalytically cracked gasoline base stock began to flow from the Aruba refinery to help increase the already substantial 100-octane aviation gasoline production by the refinery. For 6 months the catalytically cracked gasoline flowed in sufficient volume to produce thousands of barrels of the aviation gasoline daily. After a pause of but 16 days in the operation of the catalytic cracking unit for a general inspection, cracked gasoline is again flowing from the unit for a period that is expected to exceed the 6 months of the initial run. ★ ★ ★

General view of "cat" cracker of Aruba refinery, Lago Oil and Transport Company, Ltd. *(Standard Oil Company, N. J., photo.)*

NATIONAL SECURITY AWARD PRESENTED ATLANTIC REFINING

THE National Security Award of the U. S. Office of Civilian Defense was presented to The Atlantic Refining Company for its maintenance of security and protection facilities at its 600-acre refinery at Philadelphia.

Judge Harry S. McDevitt, chairman of the Philadelphia Council of Defense, presented the certificate to Howard M. Nichols, manager of the refinery, at a brief ceremony in the latter's office. Judge McDevitt praised the company's safety organization and its work at the refinery and paid tribute to its production of fuel "without which this war couldn't be won."

Accepting the award, Mr. Nichols said that the installation of the most modern type of safety and fire-prevention equipment, intensive training of employees and the full co-operation of all refinery workers had made the Philadelphia plant one of the best protected in the American oil industry. He said that in addition to adding materially to its fire-fighting equipment since the beginning of the war, the company had greatly increased the personnel of its police and fire-prevention forces at the plant.

R. F. Riegelmeier, representing the Pennsylvania Council of Defense, attended the ceremony. Others present included Lieutenant Commander J. Howard Myers, safety chief at the Philadelphia Navy Yard; D. T. Shaw, general plant superintendent; W. F. Stroud, assistant plant manager; J. Willard Lord, head of Atlantic's safety and fire prevention organization; C. J. Cutting, chief of the refinery's civilian defense activities; Thomas J. Lavin, plant protection head, and Charles McCaffrey and Louis Blourne of the plant protection organization. ★ ★ ★

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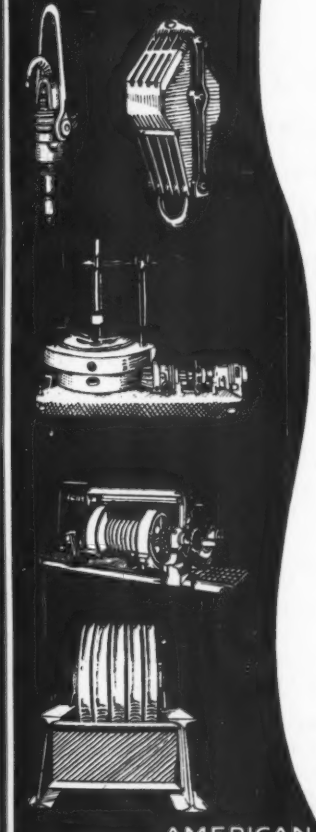

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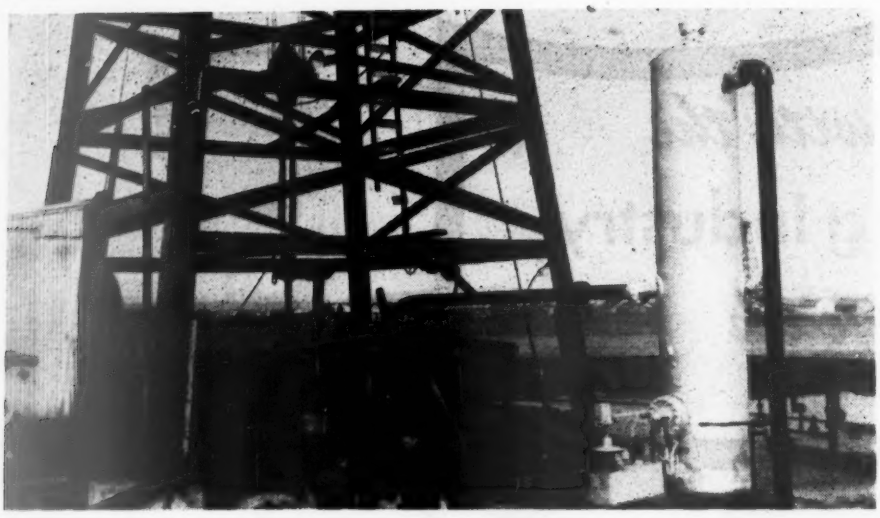

Turner Valley Royalties was the discovery oil well in the Turner Valley field.

STUDY OF PRODUCTION DATA IN THE TURNER VALLEY FIELD

By **S. F. SHAW**, Consulting Engineer

EXCLUSIVE

TURNER VALLEY oil field is situated 30 miles southwest of Calgary, Alberta, Canada, and about 150 miles north of the Montana state boundary. It lies in the foothills of the Rocky Mountains at an elevation of about 4000 ft. The combined oil and gas field is about 20 miles in length and up to 2½ miles in width. The gas reservoir covers about 10,000 acres, and the oil reservoir approximately 15,000 acres. The oil reservoir varies from ½ to 1½ miles in width.

▼ **Geology.** The reservoir of the main producing zone lies in the Madison or Rundle formation of the Mississippian series. The rocks are greatly faulted, folded, and tilted, making a vertical productive gas column of 2500 ft., extending from 300 ft. above sea level to about 2000 ft. below sea level. The oil reservoir extends from 2000 to 4500 ft. below sea level, which is one of the greatest vertical ranges known for a continuous hydrocarbon reservoir.

The oil occurs for the most part in 2 porous zones separated by a dense nonproductive zone 100 ft. or more in thickness. The first porous zone is about 104 ft. thick, and the lower zone about 59 ft. thick, making an average thickness of producing formation of about 163 ft.** Porosity is low, varying from perhaps 5 to 15 per cent, although no satisfactory average porosity has been determined. Fractures and joint cracks may be contributory to a large extent in providing drainage through the formation[1].

▼ **History.** The first discovery in the field was made in 1914 in Dingman No. 1, which blew in for 4,000,000 cu ft. of gas per day in the Upper Cretaceous at 1557 and 2380 ft. The field was first known as the Dingman field. The first discovery in the Paleozoic limestone was made in 1924 in Royalite No. 4 at 3740 ft. with initial flow of 20,000,000 cu. ft. of gas per day and some 675 bbl. of 72 API gravity naphtha[7]. Covering a period of 6 years, oil was produced from Model No. 1 gas well situated close to the gas-oil contact, and although the reservoir pressure was approximately 2000 lb. per sq. in., production of oil in this well did not reach a high daily rate because of the low permeability of the limestone. During the first 6 years of life this well produced about 322,900 bbl. of oil. Dalhousie No. 8 was spudded in April, 1936, down the flank below the gas reservoir, but went into very tight limestone and did not produce oil. This discouraged operators from making other tests at that time.

Undaunted by the discouraging outlook for discovery of oil, on April 17, 1934, R. A. Brown started Turner Valley Royalties a short distance below the gas-oil contact and this well came in on June 16, 1936, for an initial of 850 bbl. of 44° API oil, and averaged 796 bbl. a day for a period of 15 days during that month. The next well that was drilled into the oil reservoir was Foundation Royalties No. 1, on which work began June 14, 1934, and was completed November 16, 1936, averaging 226 bbl. a day without acidizing for 21 days in December, 1936[6]. The writer's acquaintance with this field began at Foundation No. 1 in April, 1937. The third well was Sterling Pacific No. 3, begun May 7, 1936, and completed December 1, 1936, making an average of 75 bbl. of oil a day for 21 days in December of the same year. A drilling campaign thus was initiated that continues to the present time. In April, 1944, there were 226 wells listed as producing in the Madison limestone, and 24 drilling operations.

▼ **Drilling and completion.** The drilling campaign was not prosecuted as rapidly in the Turner Valley field as would have been the case in most oil fields, owing to several factors. The cost of completing a well has ranged from $150,000 to more than $200,000. The length of time required to complete a well is about 6 months and because of the great thickness of hard rock encountered, about 235 rock bits are required to complete the job[4].

Wells have been drilled for the most part with rotary outfits although a few wells in the early days were drilled with cable tools. In many wells mud is used while drilling through the reservoir rock, but in others the drilling fluid is oil. Surface pipe consists of 600 to 700 ft. of 13⅜-in. pipe and the producing string usually is 7-in. O.D., 26-lb. pipe set just above the upper porous section and cemented to about 300 ft. above the lower end of the pipe[4]. In recent operations in some of the wells a section of liner is set between the two porous zones in order that a packer can be set in this section to separate the two zones when desired.

After completion of the drilling operation all wells are acidized, usually with 10,000 to 20,000 gal. of acid. Potentials on natural flow before acidizing range from 100 to 200 bbl. a day and after acidizing the potentials established are from 500 to 900 bbl. a day[4]. The largest potential established in any well in the field was that of Frontier No. 1, which, after acidizing, flowed 7617 bbl. of oil in a full 24-hr. period.

Drilling and completion operations, production methods, proration practices, ultimate recovery, and extraction results discussed with supporting records.

▼ **Producing operations.** In 1936 the price of oil was $1.55 a bbl. for 40° API gravity oil. As development progressed and the supply of oil was increased, the price was reduced until 1939 when it reached a low of $1.14 per bbl. Transportation rates were such that the oil from this field could not be moved beyond a certain distance from the field without running into competition with oil from other sources; consequently in early years when the demand was re-

*References at end of article.

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duced in the winter months, the supply exceeded the demand and the wells had to be restricted. In the summer months the demand approximated the available supply and many of the wells were opened at near maximum capacity.

Nearly all wells are completed with 3-in. tubing, and all wells but two have produced on natural flow up to the present time.

In the early days of the field, it was found that gas-oil ratios increased rapidly during the summer months when the production was increased, and decreased during the winter months when restrictions set in. This naturally led to the belief that reducing the production would result in an overall average reduction in the gas-oil ratio and consequently in a higher ultimate recovery. Also, the rapid production of gas during the summer months resulted in discharging large quantities of gas into the air, which appeared to be a huge waste because the quantity of gas was so great gas that was being vented.

▼ **Proration practices.** Proration was set up early in the life of the field to regulate the production to fit demand. This was first based upon the ability of the well to produce. As almost all wells were drilled on a uniform spacing of 40 acres and the formation was so tight that relative interference within this spacing was virtually negligible, this method served the purpose satisfactorily at that time. In the course of time, however, proration formulas began to make their appearance, involving acreage, ability of the well to produce (productivity), gas-oil ratio, and bottom-hole pressure. The large quantity of gas being discharged into the air brought about the introduction of the gas-oil ratio into the formula, and because the gas-oil ratios in the small wells were the highest, the productiton of these wells was so restricted that there was no chance for them to pay out.

In 1942, the Brown plan was introduced and has prevailed to the present time. In this method, wells are permitted to produce 25 bbl. of reservoir fluid per acre per day, which includes gas as well as oil[6]. The Brown method depends, of course, upon having an accurate knowledge of reservoir conditions, including reservoir pressure, quantity of gas dissolved in the oil under different pressures, temperature of the reservoir, etc., in order to arrive at the exact quantity of oil delivered at the surface necessary to make up this quantity in the reservoir. Study of the physical characteristics of the reservoir fluid thus made obligatory is a big step in the right direction. Weak points in the method are the lack of knowledge about the actual reservoir pressure surrounding the well, and about the quantity of oil that underlies a given tract. Many tests were made in the early days of the field to determine the reservoir pressure and it was found necessary to close in wells for periods of 15 to 45 days for the well pressure to reach an equilibrium with the reservoir, consequently shut-in periods of 24 hr. can be only the roughest kind of a guess of the reservoir pressure. Under this method an area containing several times as much oil as another area has an allowable that is the same per day of reservoir withdrawal as that of the smaller well, under which condition there is the danger of oil migrating from the large well to the small well. Of course, the quantity of 25 bbl. per acre per day is not considered sacred; it can be changed to some other rate to meet the demand, and this matter is now being studied by the Alberta Conservation Board.

The need for proration brought about the appointment by law of the Alberta Conservation Board, which maintains records of the production of oil and gas from each well. Records are required from the producer of the quantity of oil and gas produced each day, and of the tubing and casing pressures. Periodically 24-hr. bottom-hole shut-in pressures are taken; also the maximum formation temperature is taken. Thus a most valuable record has been maintained of each well from the early development of the field, and the board publishes a report of the production data each month, a copy of which is supplied to each operator. Thus studies can be made of the results of the different production methods that have been employed in the field. It is from these records that the accompanying figures are taken[6].

TABLE 1

Estimates of ultimate recovery of oil in the Turner Valley oil field

Estimator	Probable area of the field in acres	Estimated ultimate recovery, bbl.	Average recovery per acre
T. A. Link and S. J. Davis	17,000	105,000,000	6,176
Alexander Deussen	12,872	130,000,000	10,100
S. F. Shaw	11,000 to 14,000	110,000,000 to 165,000,000	10,000 to 11,800
Stanley Gill	19,000	200,000,000	10,500
B. B. Boatright	15,000	177,000,000	11,800

TABLE 2

Estimates of ultimate recovery of gas in the Turner Valley gas field

Year	Estimated ultimate recovery in billions of cu. ft.
1930	556
1932	934
1934	1046
1936	1162
1938	1248

▼ **Estimates of ultimate recovery.** Various estimates have been made of the ultimate recovery to be expected from the Turner Valley field. The earliest published estimate available[1] of the gas reservoir by the porosity-area method, using an average porosity between 10 and 20 per cent and thickness of 50 to 100 ft., indicated an average reservoir capacity of 100,000 bbl. per acre, and by the pressure-volume method a capacity of 126,000 bbl. per acre was indicated. The area covered by the gas reservoir was taken as 10,000 acres. Applying the same porosity to the supposed oil reservoir, a shrinkage factor of 50 per cent and a recovery factor of 25 per cent for an area of 5000 acres, there results an ultimate recovery of about 62,500,000 bbl. of stock tank oil. This was intended only as a rough guide, as only meager data were available from the single oil well that had been drilled in the field to that time. Early in 1939, several estimates of ultimate recovery were made as given in Table 1[3].

Estimates of recovery from the gas reservoir by Katz and Brown, employing the material balance method and based on field development as of a given date, are given in Table 2.

Estimates on the oil capacity of the reservoir by Katz and Brown, using the material balance method as of given dates, were 134,800,000 bbl. as of June 30, 1939, and 159,000,000 bbl. as of September 30, 1939, from which it was deduced that the area of 5000 acres then considered as being drained would con-

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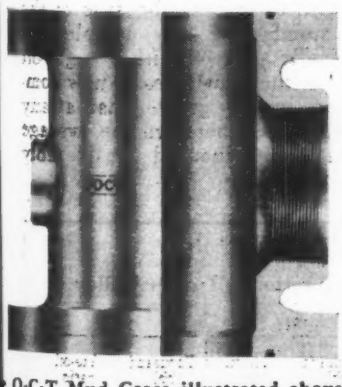
interchangeable stripper type packoff.



O-C-T Mud Cross illustrated above is
mmended for the drilling control hook-up to
litate the return flow of mud from the well
to prevent mud flowing over the top blowout
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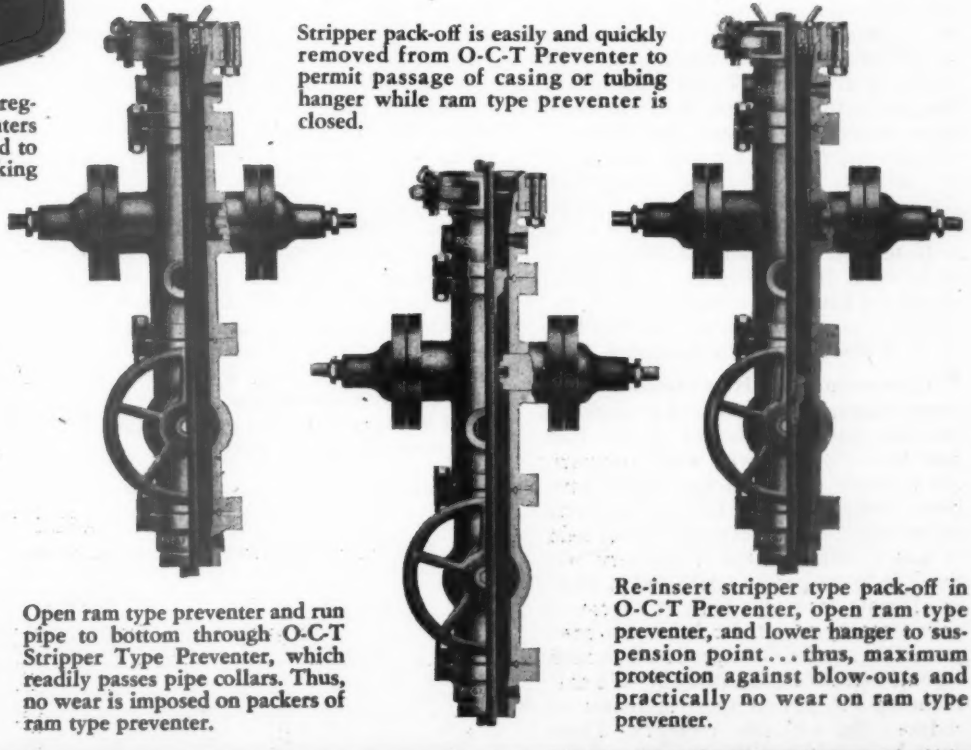

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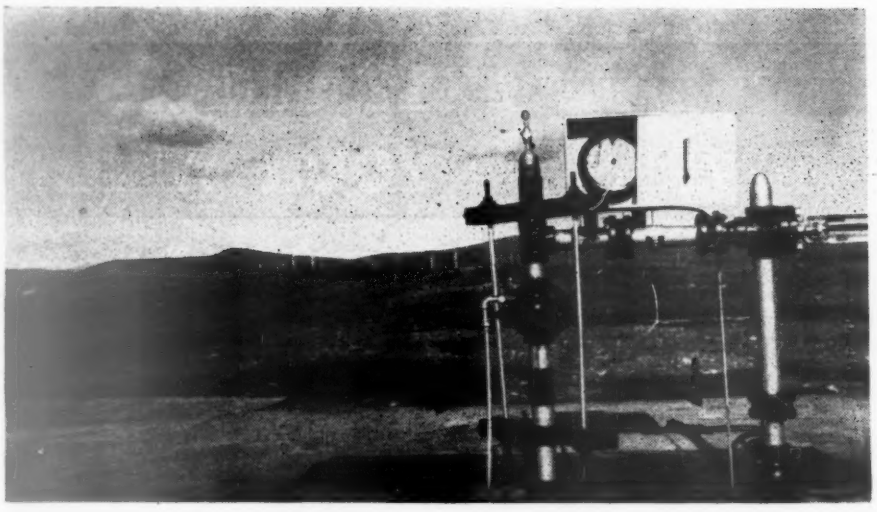

Anglo Canadian Oil Company Frontier No. 1 made the largest potential in the Turner Valley field.

tain a total of 233,000,000 bbl. and, assuming a recovery factor of 25 per cent, ultimate recovery of oil would be 58,000,000 bbl. or 11,600 bbl. per acre.

The absence of data that would serve to make a more dependable estimate resulted in estimates being little more than intelligent guesses, which may prove to be quite different from the production that will actually be obtained; nevertheless the circumstances at that time required that some sort of an estimate be made. It would appear at the present time that the recovery per acre will average appreciably less than the estimates called for. The writer is of the opinion that recovery here will be found to work out much along the line of Cutler's formula; that drilling on basis of 40 acres per well, together with restricted production, will result in the recovery of about 50 per cent as much oil as would have been recovered if the wells had been drilled on 10-acre spacing and had production been withdrawn at maximum capacity. Economically, however, the present 40-acre spacing appears to be justified; moreover, the demand did not permit extraction to be made at maximum capacity. The drilling of 3 extra wells on a 40-acre tract at $200,000 each at an extra drilling expense of $600,000 would not have been compensated by the recovery of an additional 400,000 bbl. of oil at prices that have prevailed.

▼ **Extraction results obtained.** This study primarily is not one of economical recovery but of extraction results that have been obtained, with which comparison is made of results that might have been obtained under different methods of operation. The theory now widely held is that restricted rates of recovery will result in lower gas-oil ratios and in higher ultimate recovery. This, of course, is only a theory as yet, for it has not been proved in any field yet produced to such a point that it can definitely be said that reducing the gas-oil ratio increases or reduces the ultimate recovery. There must be considered the question of the use of the energy in the gas rather than the actual quantity of gas; also the propulsive effect of high pressures in the early life of a field as against gradually lowering the pressure under restricted productive rates. In the Turner Valley field, probably 75 per cent of the energy in the gas has been dissipated at the tubinghead where the oil and gas are discharged from the well, instead of being utilized in pushing the oil through the reservoir rock. Analyses cannot be made that reveal definitely the physical effects of producing at maximum rates, which was the method employed in the early days of the Gulf Coast fields, in the fault-line fields of Powell, Wortham, and Mexia in the Woodbine sand in Texas, and in the Luling and Salt Flat fields in Edwards porous limestone, where exceptionately large production was obtained. It is known that there were recovered very large quantities of oil per acre and per acre-foot under these production methods.

Next is the question of gas-oil ratios in Turner Valley. Mention was made earlier in this article that the gas-oil ratios were reduced in the early life of wells when the wells were restricted during the winter months, but in this connection the usual results in almost all oil fields are that gas-oil ratios gradually increase up to some peak point as the wells grow older. It can therefore be expected that oil that is deferred must later be produced at an increased gas-oil ratio when, if ever, it is produced. In fields with closer spacing and with rapid withdrawals, this peak is gas-oil ratios comes at an early date, after which the gas-oil ratios decline. In widely spaced wells where withdrawals are at a low rate, this peak point may never be reached, or rather the point may never be reached where a reduction in gas-oil ratio begins before the economic limit of oil withdrawals is reached, and this has been the case in the Turner Valley field. This condition probably applies more particularly to reservoirs of low permeability. In highly permeable sand where production is at maximum capacity, as was the case in the Wilcox sand at Tonkawa and Seminole, gas-oil ratios did not increase to any considerable extent throughout the life of the field. Gas was not measured over the life span of the wells in the fault-line fields but the meager measurements that were taken tend to indicate that these fields acted much as did Tonkawa and Seminole.

It has been observed of late years at Turner Valley that in many cases great restrictions in production of oil result in increased gas-oil ratios and that considerable increases in daily oil withdrawal rates are accompanied by reduced gas-oil ratios. This does not occur in all cases, however, and it may be premature as yet to draw any definite conclusions in this respect. Fortunately, the valuable data recorded by the Alberta Conservation Board for the last 7 years can be drawn upon to study the effect on gas-oil ratios of large withdrawals over a period of time as compared with low withdrawal rates, and various tables are presented here to bring out the results that were obtained. Average figures on production of oil and gas-oil ratios over a period of 4 years are given in Table 3.

The figures for gas-oil ratios in Table 3 are not quite correct, for wells with very high gas-oil ratios have been removed from the list of oil wells and classified as naphtha wells thereby making an apparent reduction in the average gas-oil ratios given in the table. The peak average gas-oil ratio was reached in the month of April, 1941, after which there seems to have been a gradual decline until January, 1943, when ratios again began to increase because of the reduced number of new completions, which usually start off with low gas-oil ratios. Also, the allowables in new completions are usually greater than at any subsequent time, therefore the average gas-oil ratio is influenced considerably by new completions.

TABLE 3

Monthly production of oil and of average gas-oil ratios at Turner Valley

Month	1940		1941		1942		1943	
	Thousand bbl.	Gas-oil ratio	Thousand bbl.	Gas-oil ratio	Thousand bbl.	Gas-oil ratio	Thousand bbl.	Gas-oil ratio
January	437	3610	750	3820	817	3530	791	2770
February	607	3110	689	4010	792	3360	706	2940
March	525	3350	799	4080	865	3380	773	2890
April	591	3440	780	4190	796	3380	753	2990
May	631	3640	802	4140	842	3310	789	3110
June	615	3580	773	4150	801	3220	738	3140
July	827	3510	823	3920	811	3040	756	3230
August	818	3840	825	3900	814	2980	760	3200
September	790	3970	832	3770	765	2850	729	3210
October	770	3940	817	3700	797	2950	754	3280
November	842	3730	804	3630	773	2890	703	3260
December	689	4030	820	3550	795	2890	696	3410
	8143	3670	9504	3900	9668	3150	8940	3120

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Before studies can be made of comparative gas-oil ratios in these wells, it is necessary to classify the wells into zones on the structure, otherwise the general averages are so confusing as to possess no significance.

It was observed early in the development of the various zones that the oil was of lower gravity as the wells reached to lower sub-sea levels; also gas-oil ratios of these wells of greater depth were lower initially than in upper zone wells and have continued lower throughout their history. It was also observed that after several years' production the average cumulative gas-oil ratios settled to lower points in wells produced at high daily rates than in wells produced at low daily rates.

To show the effect of position on structure on gas-oil ratios, Table 4 was prepared in which the cumulative production of oil in all wells and the cumulative average gas-oil ratios of wells are arranged in groups to the end of 1943. The zones are arranged in three sections in vertical elevation. That lying between 2300 to 3000 ft. sub-sea level; between 3000 and 4000 ft., and between 4000 and 4600 ft. The groups are arranged by years during which they were completed, beginning with 1937. The field has also been further subdivided into north and south sections, as there is an area of very low porosity between the two sections, thus separating the field into two distinct productive areas.

It may be clearly observed from the figures in the table that the zones of higher structural elevations have produced with higher gas-oil ratios, consequently comparisons must be made only when bearing these differences in mind. The figures in Table 4 also indicate that, in general, the areas producing the larger quantities of oil have produced at lower gas-oil ratios, and yet even with these segregations there are anomalies in that it is not so clear as could be desired that the wells producing at higher rates of withdrawal obtained the lower gas-oil ratios; therefore, the individual wells in the various zones and sections have been further classified into sub-zones in intervals of 100-ft. vertical ranges of elevation.

Results of individual wells in Zones S-2 and N-2 classified in vertical ranges of elevation of 100 ft. are shown in Table 5 in order to make the results clearer.

TABLE 4

Production of oil and cumulative average gas-oil ratios by groups of wells

Year in which wells were completed		Zone					
		S-1	N-1	S-2	N-2	S-3	N-3
1937	Thousand bbl.....	6850	....	2483	....	....	....
	Gas-oil ratio.....	7170	.....	3290	....	....	....
1938	Thousand bbl.....	2825	343	6950	....	471	....
	Gas-oil ratio.....	5670	5300	3630	....	1580	....
1939	Thousand bbl.....	....	....	5061	310	2402	1539
	Gas-oil ratio.....	....	....	3600	4470	2191	1380
1940	Thousand bbl.....	75	292	3413	1410	1869	2140
	Gas-oil ratio.....	10050	4230	2700	2380	2170	1400
1941	Thousand bbl.....	80	137	2220	1082	1200	2497
	Gas-oil ratio.....	4800	5920	2320	2170	1890	1410
1942	Thousand bbl.....	88	....	367	1130	156	2303
	Gas-oil ratio.....	5920	....	1720	3090	1530	1440

TABLE 5

Cumulative production and cumulative average gas-oil ratios to the end of 1943, of wells completed in 1938, in zones S-2 and N-2

Well	Minus sub-sea elevation, ft.	Cumulative bbl.	Cumulative average gas-oil ratio, cu. ft. per bbl.
Zone S-2			
M-S-R No. 2	3000	308,347	4530
Brown No. 5	3096	126,132	11450
Vulcan Brown	3136	684,044	2680
Globe	3143	202,644	5050
Trail	3103	167,477	6170
United No. 5	3233	337,081	4280
Davies No. 2	3202	317,399	3760
Royalite No. 34	3263	108,568	5850
Sundance	3377	474,676	4030
Royal Canadian No. 2	3305	322,867	4620
Royalite No. 33	3364	237,342	3500
Royalite No. 30	3440	513,003	2560
Sunset No. 2	3476	359,678	1985
Commoil No. 2	3400	341,299	2540
Royalite No. 32	3419	216,534	4250
York Oil No. 1	3545	426,495	2710
Pacific No. 3	3569	310,900	3010
Coronation	3612	349,285	3150
Command No. 1	3661	310,341	4030
National Petroleum No. 2	3688	159,004	5230
Deep Oils	3896	445,088	2420
Royalite No. 31	3814	223,367	3340
Zone N-2 (wells completed in 1940)			
Foothills No. 5	3637	398,314	2390
Home No. 5	3775	293,081	2620
Foothills No. 6	3707	249,804	2690
Home No. 1	3875	468,702	1400

From an examination of the figures in Table 5 there can be little doubt that under otherwise similar structural conditions, wells that have had the higher withdrawal rates have obtained the lower gas-oil ratios. There are exceptions to this statement; some of the exceptions, however, are due to factors in production practices that will not be discussed here.

From Tables 4 and 5 it appears that the result of restricting production in the Turner Valley field tends to increase, rather than reduce the cumulative average gas-oil ratio. This in itself may or may not affect the ultimate recovery, because this is very difficult to prove one way or the other with the data so far available.

There is yet the case to be analyzed of how restrictive measures in themselves have affected the ultimate recovery of oil, whether it be due to increased gas-oil ratios or to the results of not employing most effectively the reservoir pressure available in the initial stages of the field.

It is generally believed that the decline method of plotting production on log-log paper gives the most reliable index of future recovery but for the most satisfactory results this depends upon producing the wells at maximum withdrawal rates, or perhaps at some rate that is a uniform percentage of the maximum rate. This method often shows a tendency for the decline curve to flatten toward the later years thus resulting in a conservative estimate of ultimate recovery. For the most part, wells in the Turner Valley field have never produced at maximum rates over long periods of time and yet during the first 3 or 4 years of the life of the field, production was for periods of time at close to the maximum rate, and may even have been at a rate as great as was possible to obtain.

Decline curves plotted in the early years were uncertain, yet some wells in the Turner Valley field, whatever be the reason, yield a decline curve that is almost a straight line on log-log paper throughout their 7 years of life. Much the greater number of wells show decline curves that suddenly assumed steeper dips between 1939 and 1941, due presumably to methods that became more restrictive.

If the future recovery as indicated by the decline curve, in wells where production has been deferred, is to be made up and is to exceed that which would have been produced by the method of maximum withdrawals, or is even to make up the deferred oil, it obviously becomes necessary for the decline curve again to assume a flatter dip before it becomes necessary to abandon the wells. Yet this flattening has not taken place on these curves for wells in the Turner Valley field and the evidence now points to the conclusion that this will never take place. Part of this effect may be due to the fact that the wells situated close to the gas-oil contact and therefore making the higher gas-oil ratios, are flooded with gas and drowned out by the invasion of gas from the gas-cap. In the Turner Valley field this means that wells

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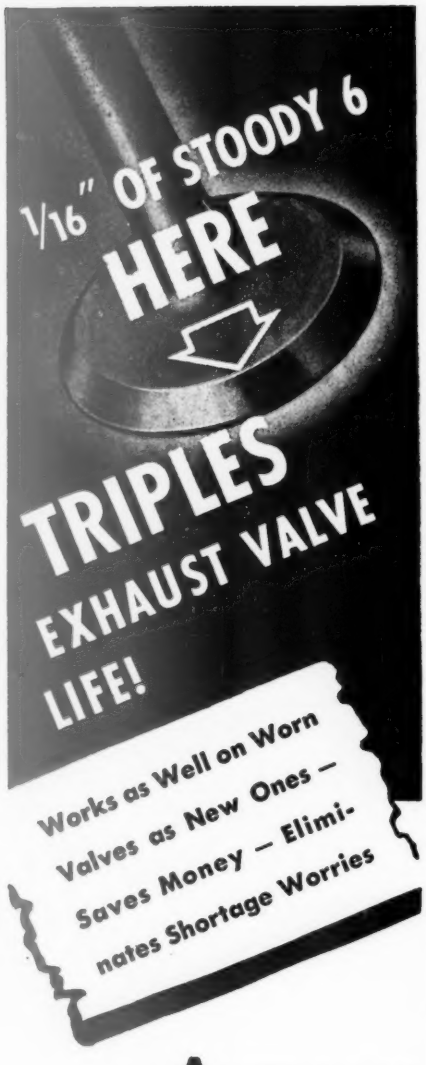
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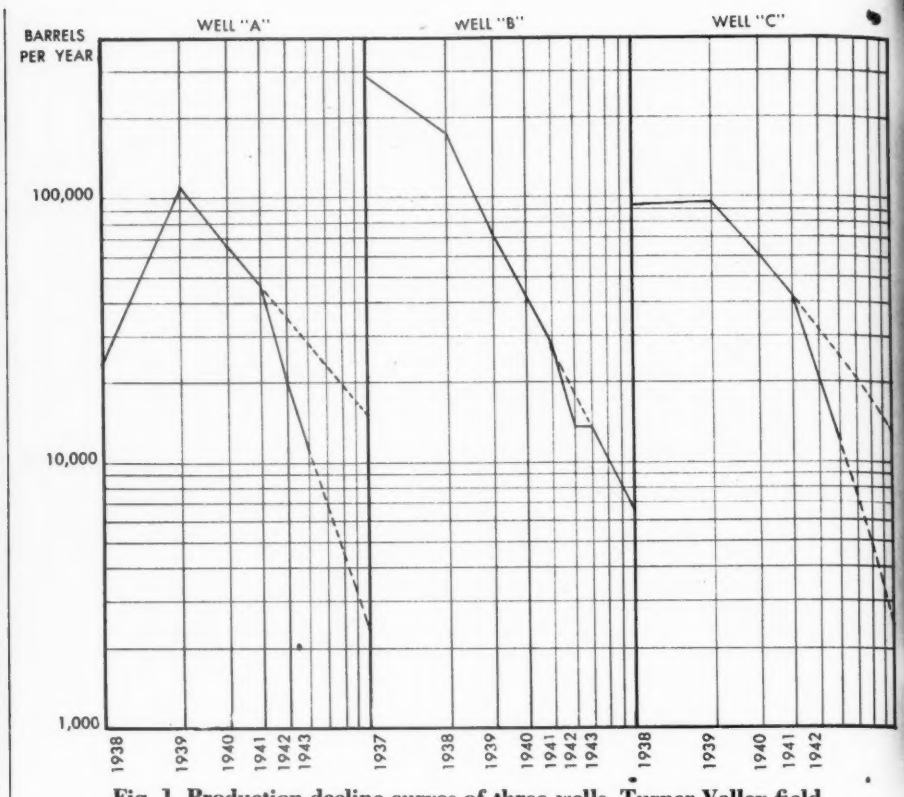

Fig. 1. Production decline curves of three wells, Turner Valley field.

still having a reservoir pressure of 500 lb. per sq. in. become classified as gas wells and become uneconomical to operate, thus preventing any chance for the production curve to flatten out and so make up the oil that has been deferred by restriction in production methods.

Fig. 1 illustrates a decline curve of a well in the Turner Valley field in which a pronounced decline takes place between 1941 and 1942. This well, designated as "A", is now a small producer and will reach the economic limit by 1945 or 1946 because of its proximity to the gas cap. Also in Fig. 1, there is shown the decline curve of well B that appears to have been restricted very little, if at all, or perhaps accidentally was curtailed at a rate that was a uniform percentage of the potential productivity of the well; but even if well B was restricted uniformly over a period of years, it still has the deferred production to make up, and because it is situated close to the present gas cap contact the decline curve does not appear as though it ever will flatten out before the oil well is abandoned. In a third well C farther down the dip, Fig. 1, a severe decline took place between 1941 and 1942. The well is now at a point that suggests its abandonment in 1946 and it appears improbable that the decline curve will ever flatten out so as to indicate the recovery of the deferred oil. Decline curves of this kind are the rule, not the exception, in the Turner Valley field.

If gas is vented to the air, it is wasted, but if it is not disposed of in this manner, it means that heavy expense must be incurred to store the gas. Operators are much concerned about the loss of gas, but they should also not be complacent concerning the loss of oil resulting from the attempts to save the gas. If the gas is valuable it should receive a price that compensates for the loss of oil that has been occasioned by restricting production, by increasing the expense of extracting the oil over a long period of time, and perhaps even by going to the expense of storing the gas. Gas in some instances is a valuable commodity, and it should command a reasonable price for the producer, who takes all the risk in drilling the well.

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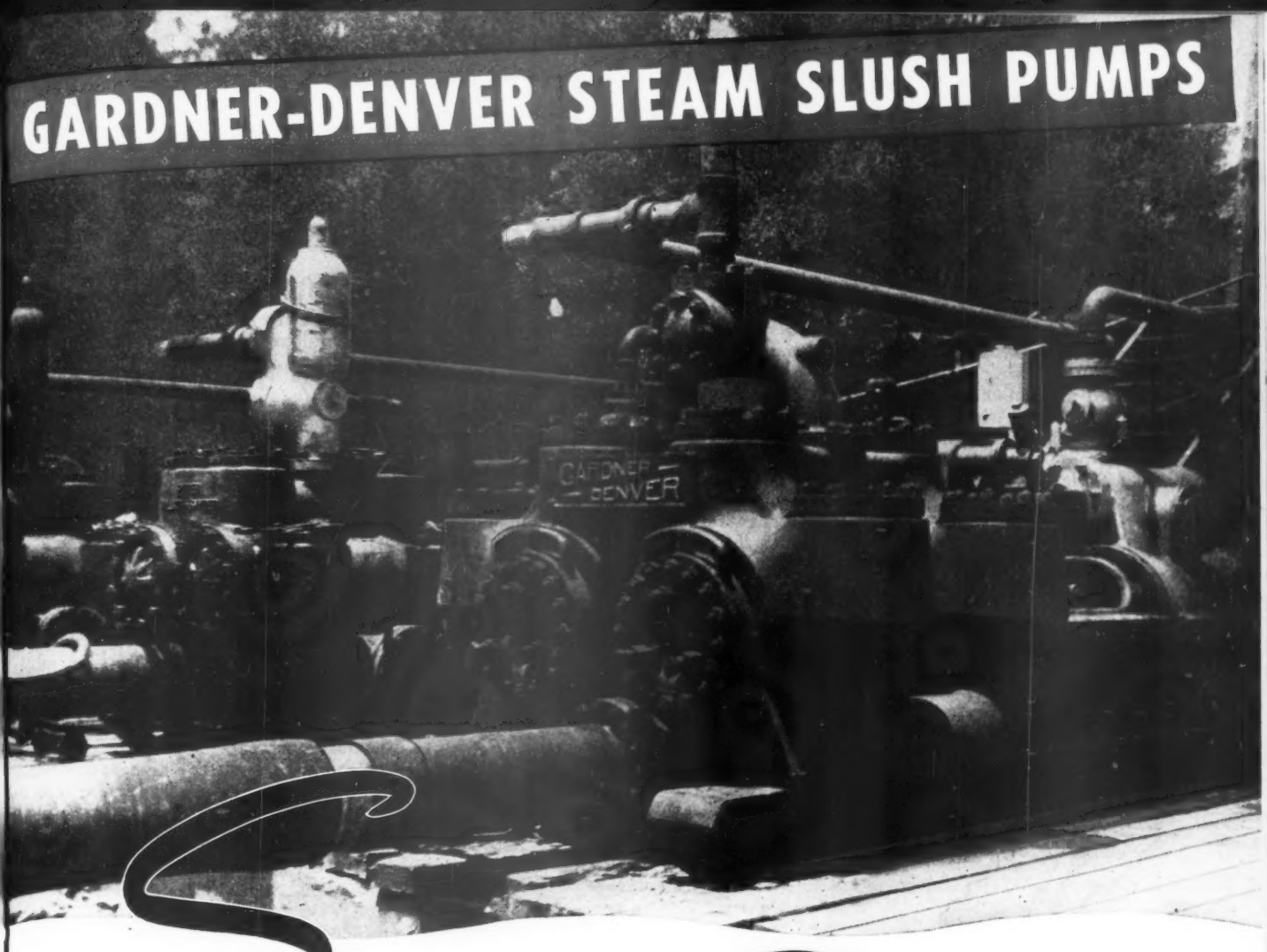

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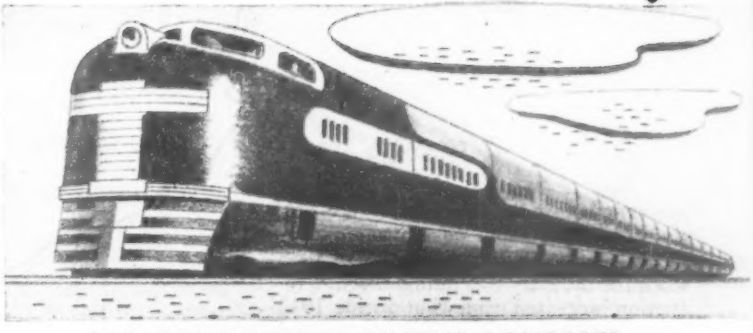

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SERVING THE OIL AND GAS INDUSTRIES

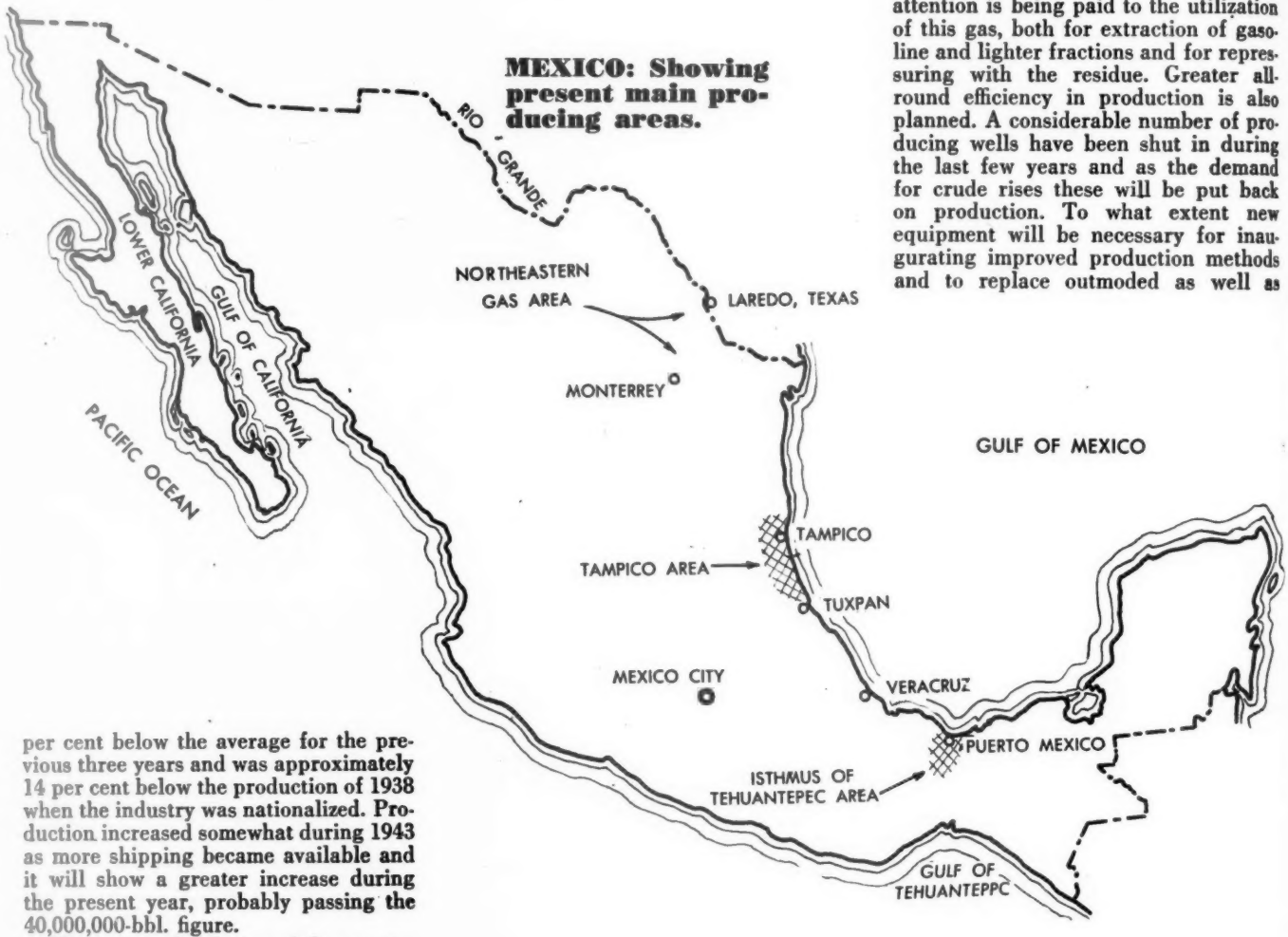
THE OIL INDUSTRY IN MEXICO

By **WALLACE A. SAWDON,** Foreign Editor

THE present production of Mexico does not indicate the actual productive capacity of that country because the lack of export facilities during the war years has curtailed production. As is the case with other countries where production can exceed domestic consumption, the total actual production depends on the volume of crude and/or refined products shipped to foreign markets. Production declined sharply in 1942 to 32,955,000 bbl., which was a drop of more than 21 per cent below the average for the previous three years and was approximately 14 per cent below the production of 1938 when the industry was nationalized. Production increased somewhat during 1943 as more shipping became available and it will show a greater increase during the present year, probably passing the 40,000,000-bbl. figure.

The entire oil industry of the country is conducted by Petroleos Mexicanos, which is owned by the Mexican government and is known as Pemex. Postwar plans of the company are reported to consider a substantial amount of refining construction that includes modernizing present plants and perhaps the building of new refineries. A great deal of new equipment will be necessary to carry out these plans and the work will naturally be delayed until such equipment is available.

Both drilling and production equipment will also have to be procured in order to develop further the present fields and to conduct exploratory work. Geophysical prospecting is being done to some extent at the present time, principally by the seismic method. The territory favorable for prospecting is of considerable extent and includes the eastern part of the country, which extends southward from the entire border of Texas along the Rio Grande and follows the coast of the Gulf of Mexico. It extends for some distance back from the coast line, however, and takes in the entire Yucatan Peninsula. Geological data also indicate possibilities in the southern part of Lower California and exploratory wells are contemplated for this area and for the mainland east of the Gulf of California in Sonora and Sinaloa. Greatest interest, however, seems to be focused on the eastern part of the country where production has been obtained.



MEXICO: Showing present main producing areas.

The producing oil fields of Mexico lie in two areas, the Tampico area and the Isthmus of Tehuantepec area. Approximately 85 per cent of the country's total production comes from the Tampico area, which includes the Northern District, Southern District, and Poza Rica. Poza Rica is the most important field and produces 75 per cent of the oil in the Tampico district and approximately 63 per cent of Mexico's entire production. The crude from this field has a gravity of from 30° to 32° API. The Southern District consists mainly of the Golden Lane where the oil is from 20° to 24° API. Oil from the fields of the Northern District is heavier, having a gravity of from 11° to 14° API.

Several fields comprise the Isthmus of Tehuantepec area, which is producing approximately 15 per cent of the country's oil. The gravity of the oil from these fields ranges from 23° to 33° API.

Considerable gas is produced with the oil in many of the fields and increased attention is being paid to the utilization of this gas, both for extraction of gasoline and lighter fractions and for repressuring with the residue. Greater all-round efficiency in production is also planned. A considerable number of producing wells have been shut in during the last few years and as the demand for crude rises these will be put back on production. To what extent new equipment will be necessary for inaugurating improved production methods and to replace outmoded as well as wornout equipment cannot be predicted at the present time. More modern drilling practices are also being put into effect.

In northeastern Mexico there are 19 gas wells to the north and east of Monterrey. Some oil seeps have been reported in this area, both east and west considerable distances from Monterrey, and between that city and Tampico. No oil production has yet been obtained in the northeastern area, however. ★ ★ ★

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PROCESSING OF WEST TEXAS SOUR CRUDES

By **L. R. GRAY**, Shell Oil Company, Inc.
Chief Technologist, Wood River, Illinois, Refinery

▼ **Summary.** This report is intended to summarize the experience gained in the Wood River refinery of Shell Oil Company, Inc., with corrosion problems encountered in processing sour crudes. Corrosion rates, use of alloys, and use of alkaline agents are included. Data are presented for topping in Section I and for cracking and coking in Section II.

Section III is included to summarize our experience in desalting crude oils, together with data that may be of value in justifying installation of salt removal facilities.

Section IV summarizes the standard safety and maintenance practices that have been adopted for the handling of equipment processing sour crude.

SECTION I

▼ **Corrosion experience—topping units.** The data included here have been obtained from the operation of a 35,000 bbl. per day topping unit, processing 100 per cent West Texas crude of about 1.5 per cent sulphur content and a salt content after desalting of 11 lb. per 1000 bbl. The unit is comprised of 3 columns, which successively take overhead hexanes and lighter, light SR gasoline, and SR naphtha. The on stream time averages 94.5 per cent. The operating cycle is 6 months per run, with approximately one week downtime for maintenance and inspection between runs. The unit is equipped with 7 direct-fired heaters, which are so manifolded that they can be shut down for maintenance and inspection as required without interrupting operation. Heater tube inspection periods vary from 100 to 180 days.

The light SR gasoline and SR naphtha are scrubbed with caustic soda at the unit to remove H_2S, while NH_3 is injected into the vapor lines from the three fractionating columns (in sufficient quantity to maintain the pH of the accumulator water at 8.4)* to reduce corrosion to the condenser shells and tubes. Chemical consumption is as follows:

Caustic soda . 0.2 lb. per bbl.
Ammonia . . 0.04 lb. per bbl.

Corrosion rates for individual equipment items are as follows:

Columns

No. 1 column. The column operates at a top temperature of 200°F. and a bottom temperature of 450°F., taking hexanes and lighter overhead. The vessel is all steel with steel trays and cast-iron caps. Corrosion allowance is 3/16 in. No significant corrosion has been observed in more than 2 years of operation.

No. 2 column. Operating temperatures are 320°F. top and 550°F. bottom, taking light SR gasoline (180-290°F.) overhead. The column is steel (¼ in. corrosion allowance) with steel trays and cast-iron caps. No significant corrosion has been observed in 4 years' operation.

No. 3 column. Operating temperatures are 345°F. top and 650°F. bottom, producing 440 endpoint SR naphtha overhead and a 680 endpoint gas oil sidecut. Originally, this column was steel (¼ in. corrosion allowance) with stainless type 405 alloy trays and caps below the feed tray, and steel trays with pressed steel caps above the feed tray. Corrosion was encountered below the feed tray. The maximum corrosion rate, observed near the reboiler return, was 6/64 in. per year. A 5/64-in. liner of 12 per cent chrome steel was installed, which covers the bottom head and shell up to the bottom of the tray above the feed tray.

Experience with corrosion at Shell's Wood River refinery summarized—corrosion rates, use of alloys and alkaline agents discussed.

A similar topping unit operating alternately on sour and sweet crude experienced similar corrosion in the No. 3 column, and a brick lining was installed, which has been in service 5 years with satisfactory results.

Some localized corrosion, observed on the top tray adjacent to the reflux return sump, has been eliminated by installing a monel liner over the area attacked.

Heater Tubes

No. 1 column reboiler. This heater is a standard Foster Wheeler heater, end fired, with radiant tubes on both sidewalls. The coil outlet temperature is 500°F. The tubes are steel, 5-in. I.P.S. with 0.375-in. wall and 6-in. with 0.432-in. wall. The maximum corrosion observed occurs in the radiant bank where an average rate of 36/64 in. per year is experienced; however, the corrosion is irregular. In some cases, ruptures have occurred on one side whereas the opposite side of the tube is relatively free of attack. In all cases the maximum corrosion occurs on the side of the tube exposed to the flame.

No. 2 column reboiler. The heaters in this service are of the strictly convection type with the tubes arranged in 11-12 horizontal rows above the firebox. The maximum corrosion rate occurs in the bottom (radiant) row, the average rate being 70/64 in. per year in this row. Life is about 6 months. The corrosion rates in the second and third rows from the bottom are 31/64 in. and 19/64 in. per year, respectively. Life of the second row is about 1 year. Above this row tube life exceeds 2 years. All tubes are standard 900-lb. steel pipe.

No. 3 column feed plate reboiler. The heaters in this service are similar to No. 2 column reboiler. Corrosion is maximum in the bottom (radiant) row, the average rate in this row being 48/64 in. per year. The corrosion rates in the second and third rows are 33/64 in. and 28/64 in. per year, respectively. All tubes are 900-lb. steel pipe.

No. 3 column bottom reboiler. The heaters in this service are similar to the No. 2 column reboiler furnaces. Corrosion is highest in the bottom (radiant) row. The rate varies widely from 6/64 in. to 36/64 in. per year, but the reason is unknown. In the second and third rows, corrosion rates vary similarly, ranging from 9/64 in. to 36/64 in. in the second row, and 6/64 in. to 24/64 in. in the third row.

Three 7 per cent chrome tubes installed in the bottom row of this heater have been in service for 3 years, and no appreciable corrosion has occurred. The remaining tubes in the bottom row of this furnace are standard 900-lb. steel pipe and have been replaced 5 times during the 3-year period.

Heat Exchange Equipment

No. 1 column condenser. The unit consists of 2 steel shells in parallel. No significant shell corrosion has occurred.

The tube bundle is made up of ¾-in. 14 B.W.G. Admiralty* tubes, and an average life of 1 to 1½ years is experienced. There is some indication of poor vapor distribution due to the deposition of salts, and provisions are being made to wash the shell side with water. These units have been in service only 2 years, and the data available should not be considered final.

No. 2 column condenser. This unit consists of 3 shells in series. The top (hot) shell was lined with monel initially, but the center and bottom shells are steel. The corrosion rate is 4/64 in. and 1/64 in. per year, respectively, in center and bottom shells. The monel-lined shell shows no sign of corrosive attack.

The tube bundles are constructed of ¾-in., 14 B.W.G. Admiralty tubes, with a minimum life of 18 months, and an average life of more than 2 years.

No. 3 column vapor-to-crude ex-

*All Admiralty tubes now used in the refinery contain arsenic, antimony, or phosphorous to reduce dezincification.

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changer. This exchanger is made up of 4 shells connected in 2 banks of 2 in series. The corrosion rate in the bottom shells varies from 1/64 in. to 6/64 in. per year, whereas the rate in the upper shells is somewhat less.

The life of ¾-in. 14 B.W.G. Admiralty bundles varies from 5 to 23 months, averaging about 11 months. It is estimated that steel bundles would last 3 months in this service.

No. 3 tops coolers. The shells are steel, and no appreciable corrosion has been encountered. Bundles made up of ¾-in. 14 B.W.G. steel tubes have an average life of 25 months. Recently the bundles have been retubed with Admiralty.

Residue-to-crude exchanger. The exchanger is composed of 4 units, connected in series, with steel shells, and tube bundles of ¾-in. 14 B.W.G. steel tubes. Corrosion to the shells is slight. The hottest bundle (where residue is 650°F.) has a life of about 12 to 13 months. The other 3 bundles have been in service 4 years. "Croloy 7" tubes were installed in one bundle (the second exchanger in series, counting from the hot end) and have been in service 13 months. Recent inspections indicate they are still in good condition.

Process piping. All process piping is steel. The maximum corrosion rate encountered in any of these lines is 12/64 in. per year.

SECTION II

▼ **Corrosion experience—cracking units.** The data included in this section have been obtained from the operation of a 15,000-bbl. per day 2-coil selective cracking and continuous residuum coking unit. The unit, which consists of 2 parallel cracking sections and a 2-furnace coking section, operates on a blend of reduced crudes of about 20 to 22 API gravity, containing 30 to 50 per cent of West Texas stocks. The operating cycle is 60 to 70 days with about 3 to 5 days' downtime for inspection and maintenance between runs. On stream time averages about 91 per cent.

Lime is injected into the unit to reduce corrosion, the amount used being 0.4 to 0.5 lb. per bbl. of topped crude charged. (It should be noted in this connection that lime has little effect where it does not actually contact the metal.) The method of inspection is as follows: Hydrated lime is mixed with topped crude in two 2400-gal. tanks, agitated by a propeller mixer placed in the bottom of the tanks, to form a slurry containing 0.5 lb. lime per gal. of oil. The slurry is injected into the topped crude stream on the downstream side of the centrifugal unit charge pump. Steel reciprocating pumps and displacement meters are used for handling and measuring the slurry.

Temperature has been found to exert an appreciable influence on the rate of corrosion. In the range of 700 to 800°F. corrosion is particularly severe, with the maximum rate occurring at about 750°F. Above and below this range, the attack decreases in severity.

Corrosion data are summarized below for the various items of equipment. All corrosion rates, unless otherwise noted, apply to operation when using lime. No ammonia is used on this cracking unit.

Light oil furnaces and lines. The furnaces are of Alcorn design, with radiant heating and soaking sections, and a central downflow convection section. During initial operation, severe corrosion was experienced in the steel convection tubes of this furnace, which charges a 660 end-point gas oil. Corrosion rates were 20/64 in. per year in the top (outlet) tubes and 11/64 in. per year in the bottom (inlet) tubes. Oil temperatures in the convection section are 600°F. inlet and 800°F. outlet. The steel tubes were replaced with 5 per cent chrome, 0.5 per cent molybdenum alloy, which has been very satisfactory; metal loss is only 1/64 in. per year.

The tubes in the radiant sections of the furnace are 5 per cent chrome, 0.5 molybdenum (original equipment) and corrosion has been very low (less than 1/64 in. per year in the roof soaking section, which operates in the temperature range 900 to 935°F.).

No serious corrosion has been observed in the steel light oil hot oil pump suction and discharge lines.

Heavy oil furnaces and lines. These furnaces are of the Equiflux Type A design. Tube and line corrosion is severe in this section of the plant, and alloy is used to a considerable extent. The actual corrosion rates experienced are listed in Table 1. Since obtaining these data, the steel heavy oil hot oil pump block on the east cracking section has been replaced with 5 per cent chrome alloy block whereas the west section block was lined with 25 per cent chrome, 12 per cent Ni-alloy. The pumps will be discussed further in a separate section on pump construction.

Coking furnace and lines. Corrosion rates on this equipment are relatively mild, as indicated in Table 2. In general, tube replacements in these furnaces are necessitated by swells, cracks, and external oxidation rather than by corrosion.

Vessels. The cracking section main fractionators are steel and high corrosion rates were experienced during the initial period of operation as follows:

Location	*Approximate temperature*	*Rate in. per yr.*
At bottom baffle	735°F.	21/64
Tray 5 (L. O. drawoff)	600°F.	5/16
Tray 11	500°F.	7/64

A ganister liner was installed but proved unsatisfactory. Subsequently the ganister was replaced with a 12 per cent chrome liner (type 410), which extends upward to the bottom of the 11th tray (trays are numbered from bottom up).

The light oil accumulators, which operate at about 600°F., were originally steel. Corrosion was at a rate of 4/64 to 6/64 in. per year, the maximum rate being observed in the center of the vessel. A brick liner was installed, but this proved unsatisfactory and was replaced with a type 410 liner.

The flash chambers on the cracking

TABLE 1

Corrosion rates—heavy oil furnaces, pump and lines

Dubbs No. 17	Material	Operating temp., °F.	Corrosion rate (64th in. per year)			Ratio—Corrosion without lime / Corrosion with lime		
			Prior 1939	1940-1941	1942-1943	Prior 1939	1940-1941	1942-1943
H. O. furnace								
Convection tubes 1–12	5% chrome	735–815	8.4	9.1	12	2.5	3.9	3.7
	7% chrome		....	....	6			3.7
13–24	5% chrome		15.6	....	15	2.5		4.6
	7% chrome		None in service					
Radiant tubes 25–40	5% chrome	815–895	9.5	....	16	2.7	....	6.4
	7% chrome		....	....	8	....	....	6.4
Furnace crossovers	7% chrome		3.9	....	4	....	....	
H. O. pump blocks	Steel	700–750		24.5	32	2.5	3.1	
H. O. suction line ex fractionator	5% chrome	700–750	9.9	5.4		3.9		
H. O. discharge line to furnace	5% chrome	700–750	9.9	....		3.9		
Vapor line to fractionator	5% chrome	800–815	(same as h.o. furnace convection tubes)					
Quench suction ex fractionator	Steel	650–680		11.9	24			

TABLE 2

Corrosion rates—coking furnaces and lines

Furnace "A" coking section (Equiflux Type A)

	Operating temp., °F.	Material	Corrosion rate, in. per year
Convection tubes	800–850	5% chrome	2.2/64
Radiant tubes	850–950	Calorized 1¼% chrome	1/64
Fittings	800–950	5% chrome	1/64
Crossovers	850	5% chrome	..

Furnace "B" coking section (Equiflux Type B)

Convection tubes	800–850	5% chrome	3.4/64
Radiant tubes	850–950	Calorized 1¼% chrome	3.0/64
Fittings	850	9% chrome	..

The hot oil pump suction and discharge lines are 5 per cent chrome steel and corroded at a rate of 2/64 in. per year.

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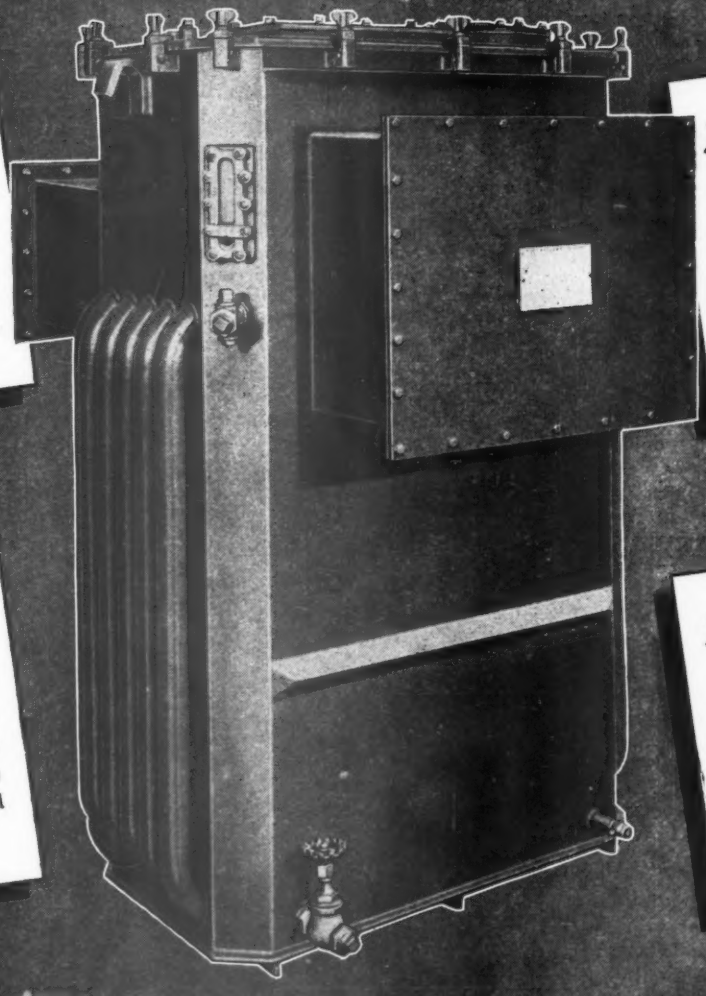

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section are steel, orginally metallized with 0.015-0.02 in. of aluminum. The metallized coating was unsatisfactory and a 12 per cent chrome liner (type 410) was installed. The corrosion rate prior to the installation of the liner is not definitely known for the liner was installed as soon as corrosion was detected. This was required because the vessel was operating at its maximum pressure rating. Operating temperatures are 840°F. bottom and 800°F. top.

The reaction chambers are steel with a metallized aluminum internal coating (0.015-0.020 in.). The metallized coating failed early in the operation of the unit but the steel vessel has not been seriously corroded in 8 years' operation. Operating temperature is 890-900°F.

The coke chambers are steel and were originally metallized with aluminum, which proved unsatisfactory. The maximum corrosion rate experienced was 12/64 in. per year at the top of the chambers, which operate at 850-860°F. The vessels are now lined with 12 per cent chrome (type 405) alloy.

The fractionator on the coking section was originally steel. Corrosion was experienced in the column as follows:

*Location**	*Temperature, °F.*	*Rate, in. per yr.*
Tray 9	Approx. 500	2/64
Tray 3	Approx. 600	4/64
Bottom	800	6/64

*Trays numbered from bottom up.

The column is now lined with 12 per cent chrome alloy from the bottom up to tray No. 11. The liner, which was originally installed up to tray 3, has been extended as required by the amount of corrosion that appears.

The stripping column on the coking section is fed from the 5th tray of the coking fractionator. The steel vessel corroded at a rate of 5/64 in. per year. A 12 per cent chrome alloy liner (type 410) is now in service.

Heat exchange equipment. The gasoline condensers on both the cracking and coking sections are of shell and tube design, with steel shells and Admiralty tubes. No serious corrosion is experienced. Tube bundle life (1-in. 12 B.W.G. tubes) averages 3 to 4 years on the cracking sections and 2 to 3 years on the coking sections.

Process lines. Both the light oil and heavy oil transfer lines were originally 5 per cent chrome, 0.5 per cent molybdenum piping. Corrosion is low — less than 1/64 in. per year. Operating temperatures are 980°F. and 900°F., respectively.

Metal loss in the drawoff line from the reaction chamber to flash chamber is high. Where steel pipe is used, rates as high as 11/64 in. per year are experienced. There are indications that this may be due as much to erosion as to corrosion. Some 5 per cent and 7 per cent chrome piping has been used with little advantage being noted over the use of steel. The temperature is about 875°F.

The residue drawoff line from the flash chamber was originally steel and corrosion rates as high as 18/64 in. per year were experienced. Most of the steel pipe has been replaced with 5 per cent chrome alloy.

No corrosion difficulties have been encountered with the steel coking furnace transfer lines, which operate at about 930°F. Rates are about 2/64 in. per year maximum, the average being about 1/64 in.

Corrosion to the vapor line from the coke chambers to the fractionator (temperature 850°F.) is severe, metal loss averaging 12/64 in. per year (maximum 18/64 in.) with steel piping. Five per cent chrome alloy is now used, and the corrosion rate is about 2.5/64 in. per year.

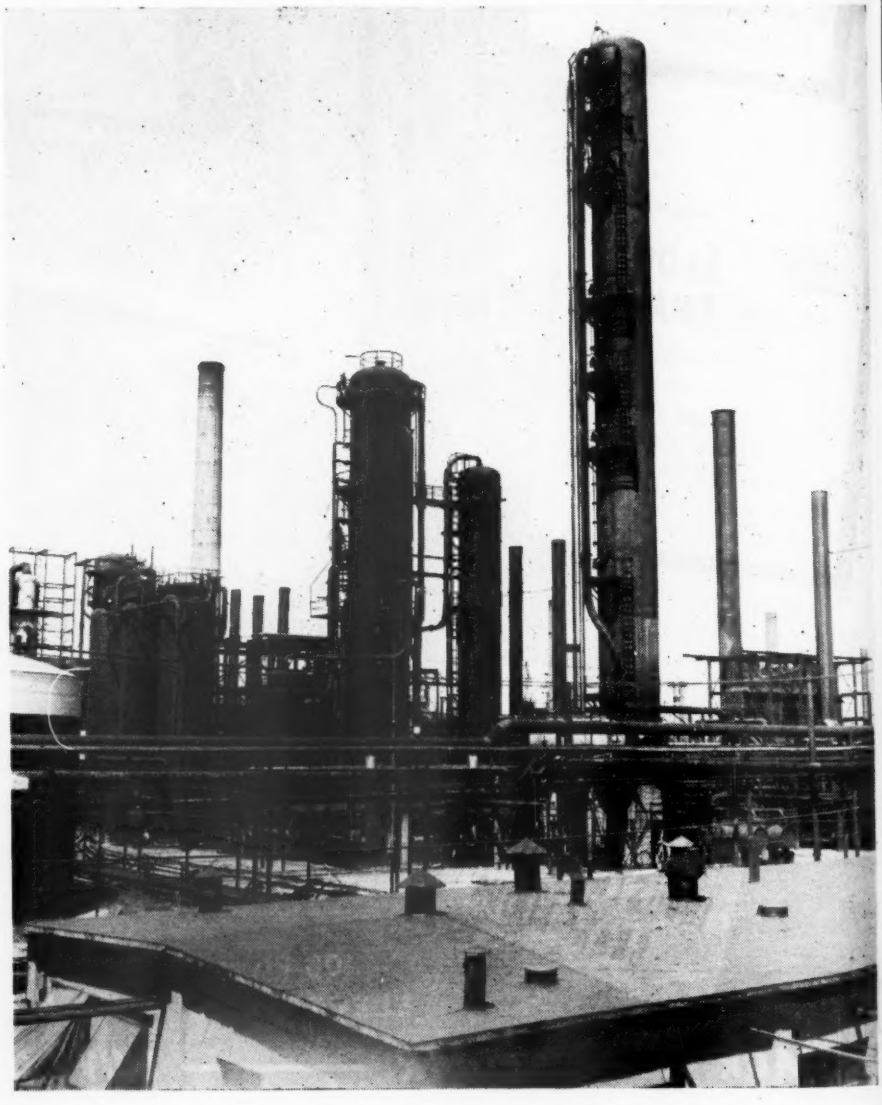
Steel tar oil lines from the bottom of the coking fractionator, (temperature 800°F.) corrode at a rate of about 12/64 in. per year. Five per cent chrome alloy is now used and losses are reduced to 3.6/64 in. per year.

Pumps. All hot oil pumps are Worthington duplex, outside-end-packed double-acting plunger pumps, with steel blocks and valve covers, heat treated stainless steel valves, valve seats and springs, and steel plungers with Janney alloy steel jackets. Corrosion to the light oil pump blocks has been light; however, the heavy oil and coker blocks are severely attacked, the rates being about 24/64 and 32/64 in. per year, respectively. Recent data indicate rates of 60/64 in. per year in the latter. The increase has been attributed to the elimination of lime injection.

In order to reduce the corrosion experienced in the heavy oil blocks, a 5 per cent chrome block was installed on the east section, whereas the west section block was lined with 25-12 per cent chrome Ni-steel by depositing weld metal in the block. As yet, no data are available to indicate how successful this lining method has been.

Inspection of pump blocks is a difficult task, for the maximum corrosion occurs internally across the web dividing the plunger chambers, and between the valve seats and plunger chamber, where the steel is subject to corrosion on both sides. Special calipers have been designed to inspect these regions. Failure at any of these points is not a safety hazard, of course, but does render the

General view of topping unit No. 4, which processes West Texas crudes at the Wood River, Illinois, refinery of Shell Oil Company, Inc. No. 1 is at right, No. 2 in center, and No. 3 at left. Salt settlers are to the extreme left of the picture.



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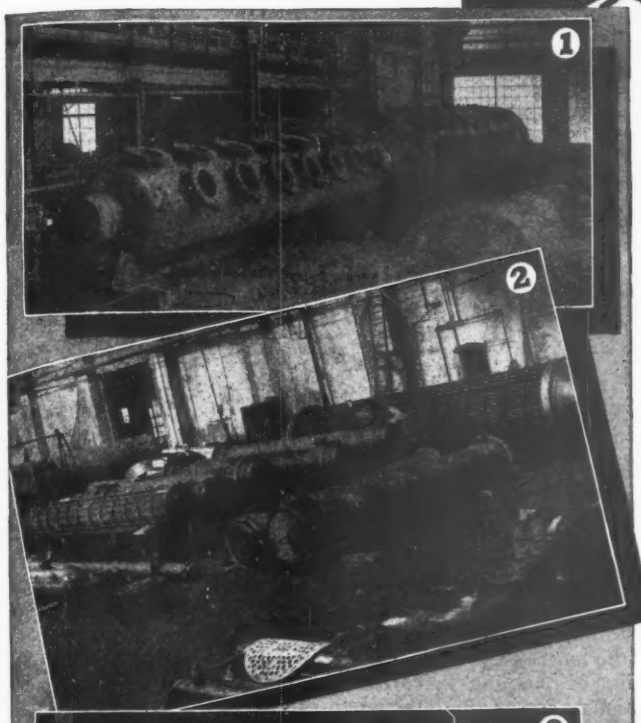


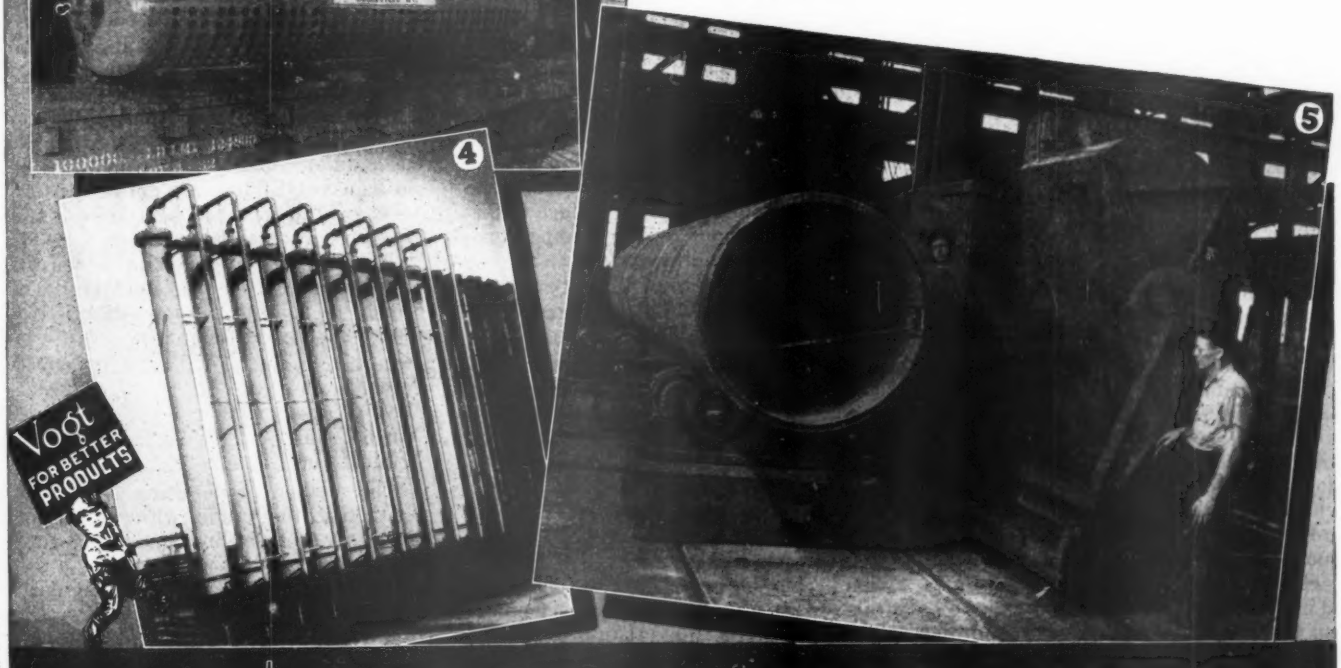
1 — 4′—0″ dia. x 7′—6″ dia. x 82′—5″ high Stabilizer Tower for a Texas Refinery. Fabricated to A.P.I.-A.S.M.E. Code, stress relieved and X-rayed. 250# working pressure.

2 — Heat Exchangers, for an Eastern Refinery, on the testing floor. Units have fusion welded Monel Metal shells and were built to customer's specifications.

3 — 48″ dia. x 22′—6″ long mud drum for a Vogt Water Tube Boiler designed to operate at 450# S.W.P. Fusion welded to A.S.M.E. Boiler Code.

4 — Battery of Absorption Columns in a Western Refinery. Units are 33″ dia. x 41′—0″ high and were stress relieved after welding.

5 — 400 KV Industrial X-ray unit in our plate welding department. Exographs of welded seams can be quickly made because of the special motor operated rolls and traveling carriages which are adjustable to vessels of any size.



VIEW OF 19 ACRE VOGT PLANT

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pump inoperative due to internal bypassing of the liquid.

Plunger liners are now made at the refinery machine shop, by shrinking 14-16 per cent chrome sleeves (heat treated to 450-500 Brinnell) on the plungers. The original steel valve covers have been provided with a 12 per cent chrome alloy (type 410) tapered sleeve cover.

Two Worthington 6-in. by 12-in. duplex piston pumps in quench oil service (operating temperature, 700°F.) were originally equipped with steel liquid ends. Corrosion was severe (5/64-12/64 in. per year), and the blocks have been replaced with 5 per cent chrome alloy.

The hot residue pumps charging the coking section are steel reciprocating pumps. Cracked gasoline reflux pumps are centrifugal with cast semi-steel case and impeller.

Storage tanks. Corrosion to storage tanks occurs primarily in 2 locations. The roof and the tank bottom and lower ring. Actual corrosion rates are available only for storage tanks handling West Texas reduced crude and cracked residue. Rates in both these services are 2/64 in. to 3/64 in. per year for roof plates and about 1/64 in. per year for side plates. Experience indicates that crude tank corrosion rates are not much greater than those encountered in residue service.

Relative corrosion rate and relative cost of alloys. The relative corrosion rate for steel and various alloys was determined on a straight run naphtha reforming furnace charging West Texas naphtha. The results are included in Table 3, together with data published by National Tube Company. These data have been found to apply to cracking processes in general without excessive error. The approximate relative cost of the alloy is included for comparison.

In general, 5 per cent chrome 0.5 per cent molybdenum steel is being used for furnace tubes and lines, except in a few locations where higher chrome contents are economical. Furnace return bends are usually installed with higher chormium content than the tubes; i.e., 7 per cent return bends with 5 per cent tubes, 9 per cent return bends with 7 per cent tubes. This has been done to avoid frequent replacement of return bends, for 2 tubes must be destroyed to replace a bend.

Liners now in service are exclusively 12 per cent chrome alloys. The higher cost of these alloys is justified by the high installation labor cost and reduction of downtime on the unit, both of which favor the use of those alloys that are sufficiently resistant to avoid frequent liner repairs and renewals.

Ganister and brick liners were installed in the main fractionator and strippers, respectively, but cracking and spalling were experienced and maintenance was excessive.

Field resistance welded stainless (14 per cent chrome) liners have been tried, and found to be unsatisfactory; excessive cracking and buckling of the liner was experienced, which permitted corrosion to the vessel behind the liner.

TABLE 3
Relative corrosion rate for alloys

Material	Relative corrosion rate		Relative cost*
	Shell data	National Tube data	
Low carbon steel	1.00	1.00	1.00
5 per cent chrome, 0.5 per cent molybdenum	0.38	0.28	3.30
7 per cent chrome, 0.5 per cent molybdenum	0.17	0.23	3.70
9 per cent chrome, 1.5 per cent molybdenum	0.11	0.19	
8 per cent chrome, 1 per cent molybdenum	....	....	4.35
18 per cent chrome, 8 per cent Ni-Ti	....	....	14.49

*Based on data in National Tube Company Bulletin No. 26 (revised 1942).

TABLE 4

Pump service	Reduced crude charge	Cracker H.P. quench	Cracker L.P. quench	Coker charge	Gasoline reflux
Temperature, °F	300	650	560	790	120
Case	Cast steel	11.5%-13% chrome	Cast steel	11.5%-13% chrome	Cast steel
Case wear ring	Nickel cast iron	11.5%-13% chrome	11.5%-13% chrome	11.5%-13% chrome	Nickel cast iron
Impeller	Nickel cast iron	11.5%-13% chrome	11.5%-13% chrome stellited	11.5%-13% chrome stellited	Nickel cast iron
Impeller wear rings	11.5%-13% chrome	11.5%-13% chrome			Case hardened steel
Shaft	SAE 3440 HT steel	11.5%-13% chrome	11.5%-13% chrome stellited	11.5%-13% chrome stellited	SAE 2330 HT steel
Shaft sleeves	11.5%-13% chrome 350 brinnell	11.5%-13% chrome			11.5%-13% chrome

The following vessels are now protected with plug welded strip liners: Cracking main fractionators, cracking flash chambers, cracking L.O. strippers, coking fractionator, coking stripper, and coke chambers. The coke chamber installations, which are in the most severe service from the standpoint of buckling due to temperature variations, have been in place up to 4 years, with results satisfactory. These installations employed type 405 strips, 0.109 in. thick and 3 in. wide, having ⅞-in. diameter plug welds on 1½-in. centers. The selection of strip and plug weld dimensions are based on the results of extensive tests conducted by A. O. Smith Corporation. These tests duplicated insofar as practicable the temperature cycles in our coking operations, and proved rather conclusively that plug welds were necessary to provide adequate heat transfer from the liner to the vessel wall to reduce differential expansion during temperature changes in the coking cycle.

Units designed for West Texas operation. An 18,000-bbl. per day once-through cracking and continuous coking unit is in service in this refinery, operating on 100 per cent West Texas reduced crude. This unit, which was designed to handle West Texas reduced crude, was provided with 7 per cent chrome alloy furnace tubes and 12 per cent chrome alloy lined columns. No corrosion difficulties have been experienced.

A quench oil heat exchanger installation preheating reduced crude charge to this unit was equipped with steel tubes. The average life is less than 2 years. Replacements are now being made with 5 per cent chrome alloy tubes. Quench oil temperatures are 665°F. inlet and 475°F. outlet; reduced crude temperatures are 375°F. inlet and 460°F. outlet.

Condenser bundles have ¾-in. 14 B. W. G. Admiralty tubes. No hydrocarbon-side corrosion is encountered. (It is standard practice to use Muntz metal or naval brass tube sheets with Admiralty tubes.)

Typical pump specifications at this unit are listed in Table 4. Liberal use of alloy is made to resist corrosion.

Effect of salt in reduced crude on corrosion. Some evidence has been obtained to show the effect of salt in the topped crude on the corrosion experienced in cracking operations. This will be discussed in the section on desalting of crude oil.

SECTION III

▼ **Desalting crude oils.** Desalting operations at this refinery have been confined primarily to two crudes, West Texas and Kansas-Healdton. Operation on the former crude is consistently good and has been standardized. The results obtained on Kansas-Healdton are not as satisfactory, and the operating procedure is still undergoing development.

West Texas crude charged consists of a mixture of southwestern crude, of which the following composition is typical:

Natural gasoline	6.6%v
New Mexico	23.9
West Texas	63.2
North Texas	2.7
Wildcat Jim	3.6

The method of desalting consists of contacting the crude with water, followed by hot settling under pressure. Under the conditions employed, a salt removal of about 85 per cent is regularly obtained, the salt content of the washed crude being about 10 lb. per 1000 bbl.

Equipment

Two 35,000 bbl. per day 3-column topping units are equipped with desalting facilities, which include the following items of equipment:

1. Three vertical salt settlers, each 10 ft. by 40 ft. equipped with an oil distrib-

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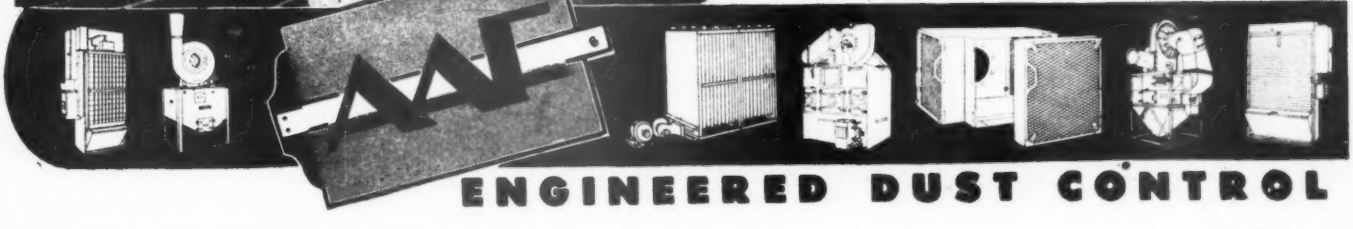


ENGINEERED DUST CONTROL

utor spider and trylines. Each distributor is constructed of 4 parallel horizontal sections of 3-in. pipe connected to a 6-in. header, drilled with 1-in. holes on 1¾-in. centers looking up alternately to right and to left at an angle of 30 deg. from the vertical. Trylines are provided on each settler, placed on 2½ to 3-ft. centers.

2. Water injection pump.

3. Caustic injection pump.

4. Brine recirculation pump (on one unit only).

5. Mixers for contacting the crude with water. Duriron, Hi-Hat, and globe valve mixers have been used.

The flow through the system is as follows: Crude oil is preheated in heat exchangers to a temperature of 220-240° F., after which water and caustic solution are injected into the crude stream ahead of the mixers. Following the mixers, the crude water emulsion enters the settlers through the distributor. (A brine level of 24-27 ft. is maintained in the settler, so that the distributor is situated 21-24 ft. below the water-oil interface.) Desalted oil flows out the top of the settler, whereas brine is drained from the bottom of the vessel using a Hancock "Flo-Control" valve to control the brine-oil interface.

Factors in Desalting

Salt is present in crude oils in two forms: (1) As brine droplets dispersed in the oil, and (2) as microscopic particles of solid salt. Both forms are frequently protected by a layer of wax or natural emulsifying agent in the crude. In order to remove the salt, it is necessary to mix intimately the crude oil with water, forming an emulsion, which then must be broken in the settling vessel. Several factors are of importance in the two operations, and are considered below. It is emphasized that these results apply primarily to West Texas crude. Variations in procedure necessary for desalting of other crude will be considered in a separate section.

(A) ***Intimacy of mixing.*** Approximately 30 lb. per sq. in. pressure drop across the mixers appears to be optimum for maximum salt removal. Higher pressure drops result in the formation of more stable emulsions, which are difficult to break; lower pressure drops do not disperse the water injected sufficiently, and desalting efficiency is reduced.

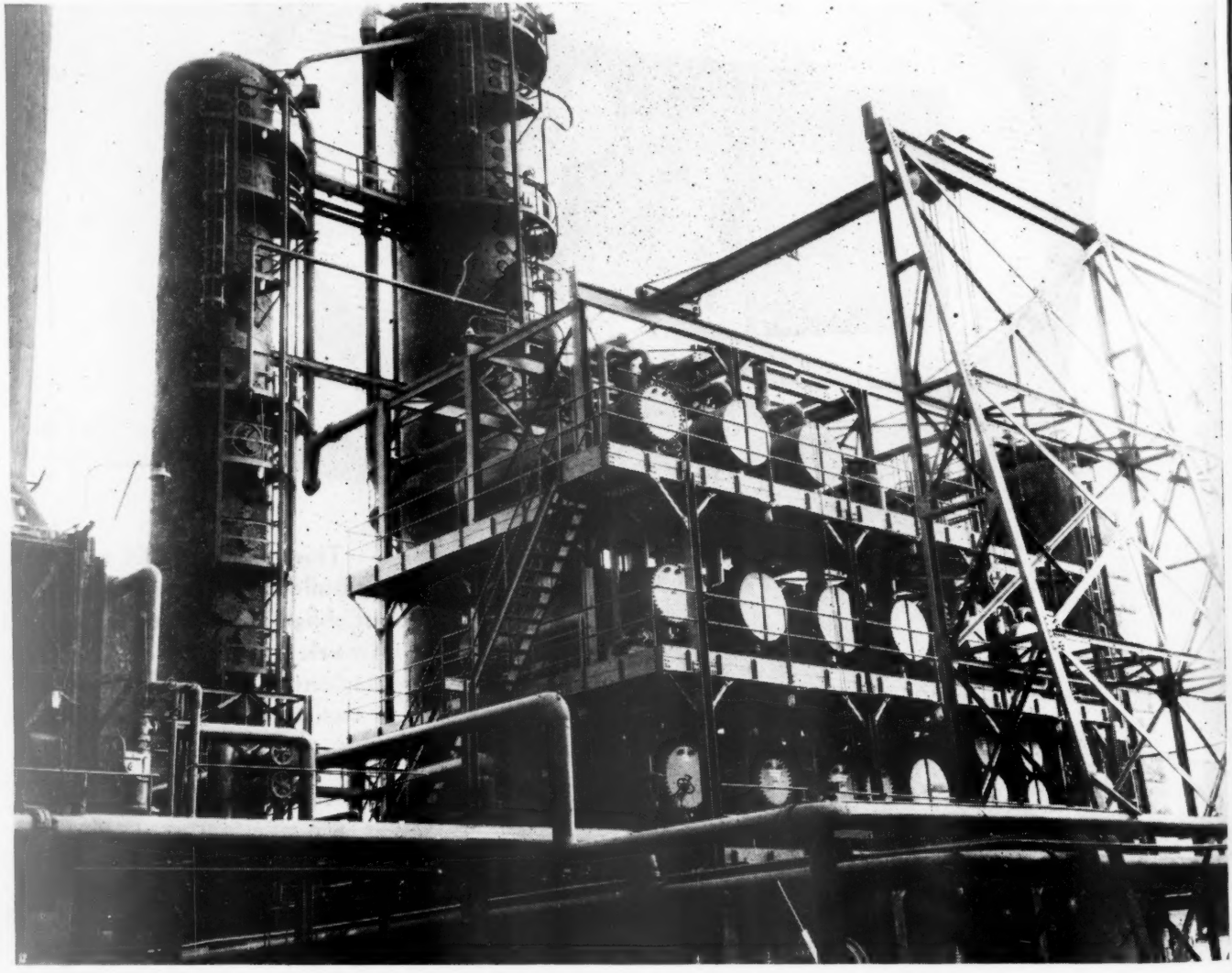
(B) ***Volume of water injected.*** Normally the water injection rate amounts to about 2.5%v of the crude, although the actual value is dependent on the salt content of the crude, and the brine concentration maintained. The latter will be discussed later.

Brine recirculation facilities were provided in the original installation (to permit recycling up to 20%v of brine), but have been found unnecessary. Actually somewhat higher salt removal efficiencies were obtained immediately after recirculation was discontinued, although this may be partially accounted for by an increase in the temperature in the salt settlers, which occurred at the same time.

(C) ***Position of water-oil interface relative to the oil injection point.*** Injection of the emulsified water and oil into the aqueous phase has been found to be essential to good desalting. The position of the interface exerts a considerable influence on the results obtained, as indicated by the data shown in Table 5.

Further development work indicated that most satisfactory operation resulted when the brine-oil interface is maintained about 20-25 ft. above the oil injection point. This indicates that demulsification occurs largely during the passage of the oil droplets through the aqueous phase.

The position of the brine-oil interface is considered to be that point where appreciable oil has begun to separate. Actually, the crude at higher levels con-



Tubular exchangers, condensers, and coolers, with No. 2 and 3 towers in left background and salt settler at extreme right. A part of topping unit No. 4, which processes West Texas crudes, at Shell plant.

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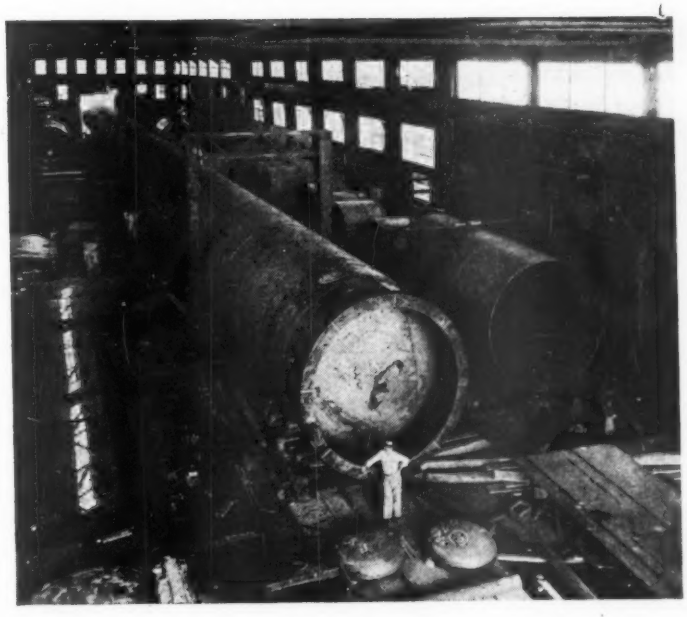
A fractionating tower 13½ by 150 ft. and weighing 250 tons, the biggest ever shipped in one piece, moved out of the Tulsa Boiler & Machinery Co. plant in West Tulsa last week, on its way to an unrevealed destination, where it is to be used in making butadiene for synthetic rubber. This huge pressure tank is one of two ordered by the same refinery.

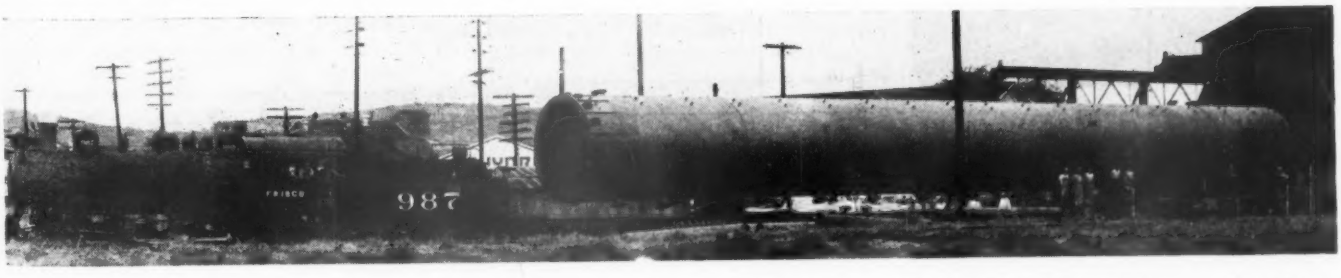
The 150 ft. of tank was shipped on three special railroad flatcars equipped with heavy cradles. The weight was supported by pivots on the two end cars, the third car running between as an idler.

Because the tank itself is 13½ ft. in diameter, it was necessary to use a railroad route which would give sufficient clearance for the tank plus the height of the car — a total of nearly 20 ft. In many sections of the country bridges or tunnels would be too small to permit passage.

Officials of the Tulsa Boiler & Machinery Co. said that though larger fractionating towers have been built, none has ever been shipped in one piece. The parts have been assembled at the refinery site.

Before the tower was shipped it was tested for leaks and strength under heavy hydrostatic pressure. When full of water, it weighed just under 2,000,000 lb. Its walls were rolled from 1⅛-in. steel.





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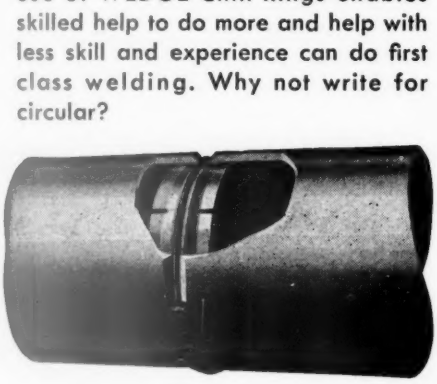

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TABLE 5
Effect of interface location on salt removal

Height of interface above oil inlet, ft	Salt removal, per cent
2	35
5	85

tains considerable quantities of water, as shown in Table 6. For the case shown, the interface is said to be 8 to 9 ft. above the inlet.

(D) ***Brine concentration.*** Operating experience indicates that a brine concentration of 2.5-4.0 lb. salt per barrel of brine is desirable for maximum salt removal and minimum water consumption. This is shown by data in Table 7. The

TABLE 6
Water gradient in salt settler

Distance below inlet, ft.	Distance above inlet, ft.	Water, %v
1½		100
4		100
	1½	
	4	95–98
	6½	
	9	80
	11½	70
	14	50
	16½	35

improved salt removal obtained may be attributed to two factors: (1) Stronger brines contain higher concentrations of those demulsifiers that occur naturally in the crude and that are extracted by the caustic soda injected into the crude, and (2) a greater differential in specific gravities of the salt solution and the crude.

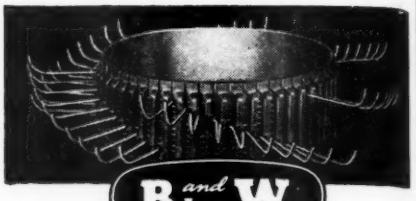
(E) ***Effect of pH of brine.*** The pH of the brine should be maintained at a relatively high value (8.0 to 9.0 is about optimum) by the injection of 5° Be′ caustic soda solution into the crude stream ahead of the mixers. Caustic consumption is low (about 0.01 lb. per bbl. crude, or less) and the higher pH, in addition to improving salt removal, tends to reduce corrosion to the salt settlers. Partially spent soda from SR naphtha scrubbers (for removing H_2S) can be used without deleterious effect to desalting efficiency.

(F) ***Operating temperature.*** Temperatures of at least 200°F. should be maintained in the salt settlers, and 250° F. is highly desirable, for the higher tem-

TABLE 7
Effect of brine concentration on salt removal

Salt content of brine, lb. salt per bbl.	Salt content of washed crude, lb. per M. bbl.	Water content of washed crude, %v
0.08	41	2.5
0.11	25	0.7
0.16	16	0.5
0.19	15	0.5
0.26	11	0.2
2.07	12	0.3
2.32	9	0.2
2.62	10	0.3
3.51	8	0.3
4.66	12	0.1
5.27	15	0.2
7.20	26	0.4

3 Ways
in which



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perature is of value in breaking emulsions. At present the settlers at this refinery operate in the range of 220-240°F.

(G) ***Operating pressure.*** The pressure is not a vital consideration. It is only necessary that the pressure be maintained high enough to avoid appreciable vaporization. The operating pressure used at this refinery is about 150 lb. per sq. in.

(H) ***Residence time.*** High residence times are of value in obtaining maximum salt removal. The data included in Table 8 will illustrate this effect. It is recommended that the throughput be limited to 500 bbl. per hr. per settler for 10-ft. by 40-ft. settlers. Vessels of other sizes may be used, but the throughput should be limited in proportion to the available residence time for the oil. Vertical vessels of smaller diameter have not been used, and no data are available concerning their efficiency. With vessels of very small diameter, the vertical oil velocity may increase sufficiently to reduce appreciably the rate of settling of the water, and, consequently, salt removal.

TABLE 8
Effect of residence time on salt removal

Throughput, bbl. per hr. per settler	Salt content, lb. per M. bbl.	
	Crude charge	Desalted crude
510	59	6
600	59	16
675	59	23

Of course, other methods of coalescing the dispersed water have been proposed, among which are the following:

(1) Gentle agitation. This is carried out by passing the oil-water emulsion through long pipes at relatively low velocity. The mixture is introduced into a settling vessel to permit separation of the two phases.

(2) Solid contact. This method utilizes a vessel packed with Raschig rings, steel wool, glass wool, excelsior, or similar material to coalesce the water. Final separation occurs in a settling vessel that follows.

(3) Centrifugal. The dispersed brine may be removed by centrifuging the crude oil.

The first of these methods is recommended by certain suppliers of proprietary treating agents and demulsifiers for salt removal. The second has been used successfully for coalescing water and treating agents in other products but we have had no experience with them in the desalting of crude.

(I) ***Accumulation of solids at water-oil interface.*** Erratic operation in the past has been traced to an accumulation of solids (primarily sand and tank scale) at the water-oil interface, which stabilizes the water-oil emulsion, resulting in high water entrainment, and poor salt removal. The difficulty can be eliminated by bypassing the settler and draining the interface material through the trylines.

(J) ***Initial salt content of the crude.*** The salt content of the washed crude is not appreciably affected by the salt content of the crude charged. Within the

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range of 50-100 lb. of salt per 1000 bbl. of raw crude, the salt content of the washed crude remains constant at about 10-12 lb. per 1000 bbl.

(K) ***Oil in effluent brine.*** No difficulty has been experienced with oil entrainment in the brine drained from the salt settlers; the oil content of the brine is consistently in the range of 0.003 to 0.007%v. The brine is drained directly to the sewer without further treatment.

(L) ***Typical operating results.*** Table 9 is included to show typical operating data when desalting West Texas crude. These data are representative of daily routine operating results at the present time.

TABLE 9

Crude intake, bbl. per hr. per settler	485
Height of interface above injection point, ft.	21
Temperature at inlet to settler, °F	230
Water injection, %v of crude	2.5
Brine circulation, %v of crude	None
pH of brine	8.5
Brine concentration, lb. salt per bbl.	3.13
Settler pressure, lb. per sq. in. ga.	160
Water content of crude, %v	0.1
Water content of washed crude, %v	0.1
Salt content of crude, lb. per 1000 bbl.	90
Salt content of washed crude, lb. per 1000 bbl.	10

Kansas-Healdton Crude

Experience has shown that Kansas-Healdton crude cannot be satisfactorily desalted using the procedure applied to West Texas. Mixing immediately preceding the salt settlers resulted in the formation of a relatively stable emulsion, with consequent high water carryover and poor salt removal.

Recently, favorable results have been obtained by recirculation of brine without fresh water injection (caustic is injected, of course, to maintain the pH). The brine is injected into the crude stream ahead of the 5 heat exchangers in series. The brine-oil mixture is gently agitated by the turbulence resulting from the passage through the heat exchangers, and no additional mixing is provided ahead of the settlers. Some water emulsified in the crude charge is removed and the salt content of the brine increases during the run. As the topping unit is operated alternately on West Texas and Kansas-Healdton crudes, this procedure is feasible; the brine concentration is reduced to normal by water injection during West Texas runs.

Use of Demulsifiers

Some tests have been made of commercial demulsifiers for crudes other than West Texas, however we have not found it necessary to apply these materials to our West Texas crudes.

Corrosion to Salt Settlers

Corrosion to the salt settlers is confined primarily to the bottom head and bottom shell region, where maximum rates of 11/64 in. per year and 7/64 in. per year have been experienced. The corrosion appears to be the result of oxygen attack, accelerated by sulphide in the presence of water. Oxygen enters dissolved in the water injected, whereas sulphide is due to H_2S present in the crude.

A ¾-in. ganister liner (Lumnite cement and ground brick ganister) has been installed in all salt settlers. Performance of the liner has been satisfactory. No deterioration of the cement has been observed in more than 2 years' service.

Analytical Methods

The water content in the crude oil is determined by the standard ASTM distillation procedure.

Salt in crude oil is determined as follows: To 200 cc. of crude oil are added, in order, 30 cc. alcohol, 30 cc. acetone, 50 cc. benzol, and 200 cc. distilled water. The mixture is shaken after each addition, and 15-20 min. after the water is added. Occasionally more benzol is required to break emulsions.

A 50 cc. aliquot of the aqueous layer is titrated with standard silver nitrate (0.1N for high concentrations, 0.01N for low concentrations) using potassium chromate indicator. Results are reported by calculating the chloride so determined as pounds NaCl per 1000 bbl. crude. Note that in the calculations, allowance should be made for the alcohol and acetone, both of which are present in the aqueous layer.

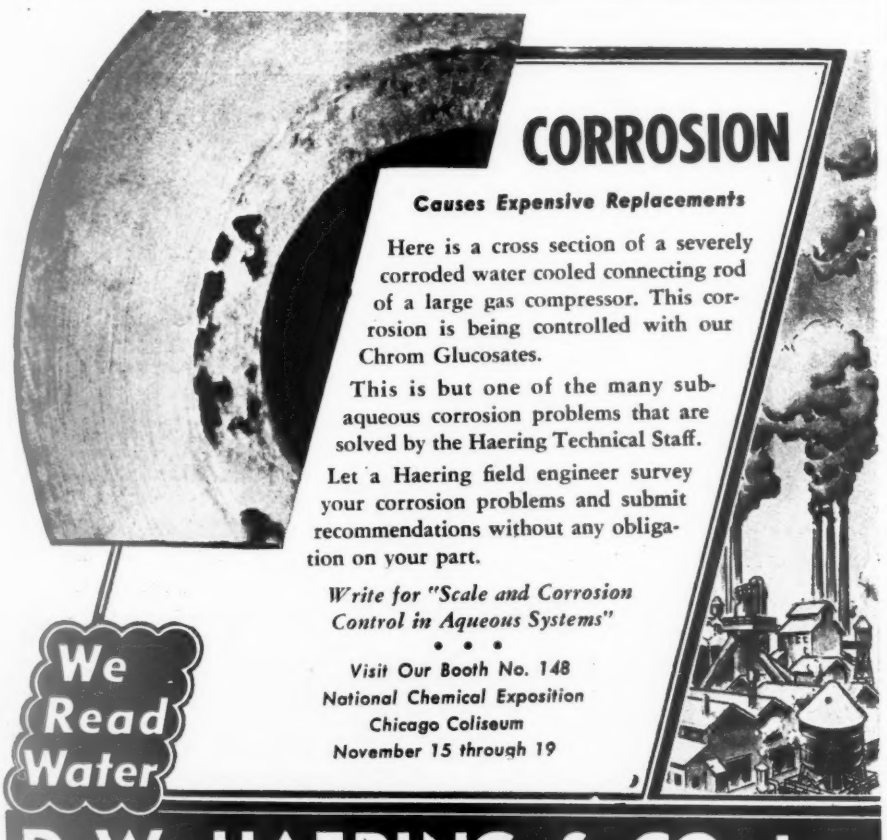
Salt in brine is determined by direct titration of the brine with standard silver nitrate and potassium chromate indicator. Results are reported as pounds NaCl per barrel of brine.

Salt Removal Justification

Justification for desalting can be summarized under two major groups: Reduction of corrosion, and reduction of cleaning of furnaces, heat exchangers, and distillation equipment. Admittedly, the exact effects of desalting may vary widely in different refineries, depending on a large number of equipment design and operating factors; nevertheless, these results should be of advantage for a preliminary estimate of profitability.

Maintenance cleaning costs on heat exchangers are definitely reduced by salt removal. On topping units it was found that desalting reduced the cleaning cycle for the residue to crude heat exchangers from 4 to 8 weeks to 8 to 12 months. No advantage is gained in the other heat exchangers, for these are used to preheat the crude prior to desalting.

A reduction in cracking tube deposition can also be claimed. No exact data are available, but indications are that a considerable portion of the tube deposit is salt. The effect is exaggerated when an alkaline agent is injected into the cracking unit charge to reduce corrosion. When using soda ash as a corrosion inhibitor (0.5 lb. per bbl.) at a cracking plant, the heavy oil furnace run length was reduced from a normal of 60 to 70 days to 30 days as a result of soda ash injection. The salt content of the topped crude charged at the time of this test was about 100 lb. per 1000 bbl. of topped crude. The solids remaining in the tube after steam-air decoking were 80 per cent water soluble, of which 1/3 was soda ash, and 2/3 salts normally found in crude oils (NaCl, $CaCl_2$, etc.). No data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are available to indicate the effect of salt alone; however, when charging residues of much higher salt content, or when operating for runs longer than 60 days the effect may be appreciable.

Desalting crude oils reduces corrosion in both topping and cracking units. Not only are salt solutions corrosive to steel of themselves, but at elevated temperatures certain chlorides, principally magnesium chloride, hydrolyze forming HCl, which is extremely corrosive, especially in condensers and other similar locations where it comes in contact with liquid water.*

On topping units a reduction of heater tube corrosion of 27 per cent was attributed to desalting. No data are available to indicate the effect on process lines and vessels; however, it is felt that desalting will be of some value here. It should be noted that these results are based on use of carbon steel pipe. Alloy piping is used at the topping units to only a limited degree, and no evaluation of its resistance to salt attack can be made.

On cracking units it has been found that desalting reduces corrosion of the heavy oil furnace tubes some 35 per cent. This applies to the use of 5 per cent chrome, 0.5 per cent molybdenum tubes. Lime injection (0.5 lb. per bbl. charge) was employed during the entire test period. Under the same conditions, a reduction of 23 per cent was observed in coker furnace tube corrosion rates.

Some data are available to indicate the effect of desalting on steel cracking tubes without lime injection. A 50 per cent reduction was observed in this case following the inauguration of crude desalting. The data were obtained at different times, however, and should be used with some reservations, especially as the ratio of sweet to sour stocks in the residue charged to the cracking unit increased during the test period.

No information is available to show the effect of desalting on process line and vessel corrosion in cracking plants. Undoubtedly a reduction occurs; however, a quantitative evaluation of the advantages of desalting has not been possible.

In addition, desalting of crude oils produces residual fuel oil of a lower B. S. & W. and ash content, asphalts of a higher CCl_4 and CS_2 solubility, and coke of lower ash content. Evaluation of these factors must, of course, be applied to each refinery separately.

SECTION IV

▼ **Maintenance and safety practices.** The chief hazards involved in the processing of sour crudes are asphyxiation by H_2S vapors, and fires caused by the spontaneous ignition of pyrophoric iron sulphide upon exposure to air. The former hazard is avoided by the use of gas masks in any location where high concentrations of H_2S exist. The latter hazard occurs in tube bundles and tanks, especially those handling light distillates, such as gasolines and naphthas, containing H_2S. This hazard can be eliminated to a considerable degree by treating to remove H_2S as soon as practicable in the process system. This is done on the topping units where straight run gasoline and straight run naphtha are caustic scrubbed before leaving the units. The caustic scrubbing has the additional advantage of reducing corrosion to lines, tanks, etc.

Gas masks used in the refinery are of 3 types. Canister type gas masks fitted with canisters for hydrocarbon and acid gases are used most frequently for general service, such as gauging and sampling crude and other tanks from which H_2S fumes are evolved. Blower masks (hose masks) are used for prolonged work in gaseous or oxygen deficient atmospheres. The blower supplying air is hand-operated for maximum reliability. Oxygen masks are also available for work in oxygen deficient or gaseous atmospheres. These are used instead of blower masks when the time required is relatively short, for less equipment must be moved to the job site. These masks will supply oxygen for at least one hour.

All respiratory equipment used should have the U. S. Bureau of Mines approval.

H_2S is qualitatively determined by the use of lead acetate paper. When any question of concentration exists, a hydrogen sulphide indicator is used.

Routine operating and maintenance practices have been established and are discussed below. The procedures used when opening vessels for inspection and maintenance are standard, and no distinction is made between sweet and sour crudes.

Handling West Texas crude. As all crudes are received in this refinery by pipe line, the operating problems involved in handling sour crude are restricted to gauging and sampling tanks. Each tank gauger is issued a gas mask for use with West Texas crude tanks. In cases where H_2S is especially severe, it is required that no man ascend to the top of the tank unless another man is nearby to aid in case of emergency. Warning signs are placed at or near the ladder or stairway on each tank containing West Texas crude. These precautions are also taken on product tanks storing oils from which H_2S is or may be evolved.

Warning signs should also be placed at sewer separator boxes and similar equipment from which H_2S may be released.

Sour crude was received at this refinery in tank cars a number of years ago. Precautions were similar to the above in that each operator was provided with a gas mask for use when opening hatches and gauging cars. In other respects, normal tank car unloading procedures were followed.

Fractionating towers. Topping unit fractionators, after shutdown of the unit, are steamed from the bottom for 2 hr., and water condensate drained from the tops receiver to the sewer. Water is then introduced into the top of the column through the reflux line and the column washed until no trace of oil is evident in the water drained from the bottom. This usually requires about 4 hr. When the water wash is complete, the top manhole is opened and a steam aspirator is placed in the manway. Steam is again introduced into the base of the column for 1½ hr., after which the bottom manhole is opened and the column is cooled by air circulation induced by the steam aspirator. During this period blinds are placed in all lines entering or leaving the column. Before maintenance crews enter the vessel the atmosphere is tested for combustible gases, using a combustible gas indicator calibrated for methane. Cases where the above procedure has failed to render the column gas-free are very infrequent. Of course, any column that is free of combustible gases is free of H_2S.

The procedure used at the cracking plants is slightly different. The column after being drained, is steamed for 1½ hr., after which water is introduced into the base of the column and oil floated out overhead. (The coke chamber cooling pumps and facilities are used for this purpose.) If maintenance work is to be done to the condensers, the water is allowed to overflow through the vapor line for ½ hr. to wash the bundle. The fractionator is then drained, manholes opened, and a steam aspirator placed in the top manway. All lines are blinded and the atmosphere tested for gas in the same manner as topping columns.

The major reason for the variation in procedure is the availability of existing facilities for filling the cracking unit columns.

Other vessels. Salt settlers and similar vessels not equipped with internal trays or baffling at the topping units are drained through the dropout line, after which the top head is opened and the vessel steamed to the atmosphere. The

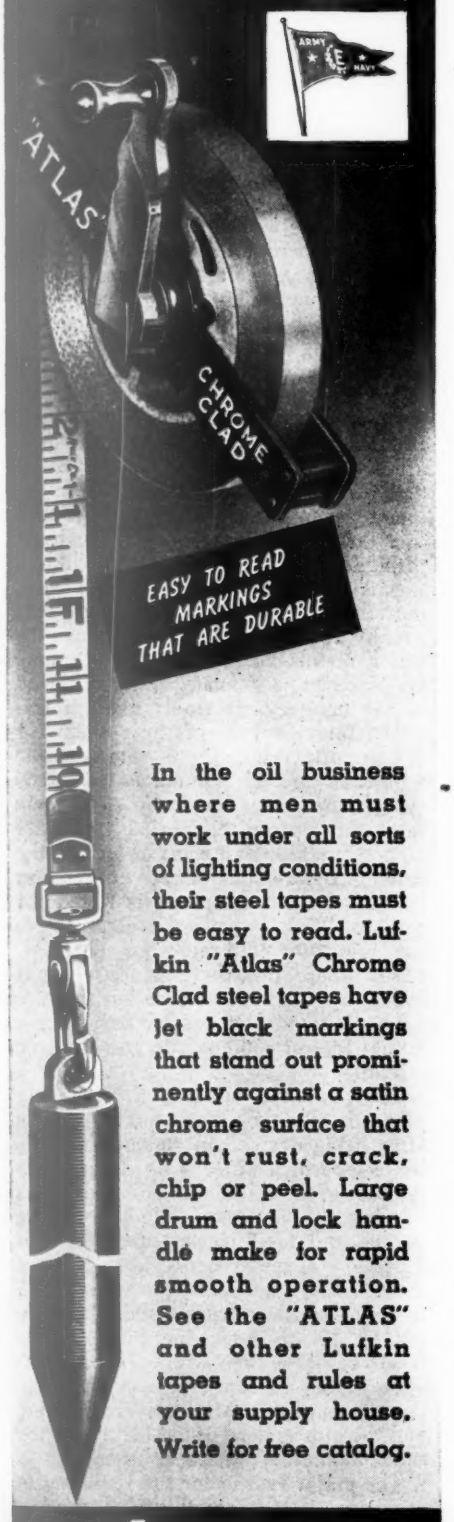
Commissions open

The Navy has a continuing need for officers who are qualified for duty as petroleum inspectors or as oil terminal supervisors. Petroleum inspectors should have a degree in petroleum or chemical engineering, plus two years actual refinery or laboratory experience in the analysis of petroleum products. Consideration will be given to applicants with 10 years experience.

Oil terminal supervisors should have had at least two years of college and a knowledge of the specifications of gasoline, fuel oil, lubricants, and aircraft engine oil. They must have had at least five years experience in the handling of bulk fuel oil and at least two years experience in a water terminal storage plant in a supervisory capacity. It is essential that they have a knowledge of loading and unloading tankers of large capacity.

*A summary of the corrosive action of salt, as well as desalting methods may be found in the U. S. Bureau of Mines Report R. I. 3422, "Desalting Crude Petroleum—A Review of the Literature."

"ATLAS"
CHROME CLAD
STEEL TAPES



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bottom manhole is then opened, an aspirator is placed at the top manhole, and the vessel cooled by air circulation.

Reaction chambers, flash chambers, and similar cracking unit vessels are steamed out for 1 hr. through the pressure drain line to the cracking unit blowoff pits. Water from the coke chamber cooling system is introduced into the vessel and discharged to the blowoff pits. Water circulation is continued until the vessel temperature drops to 150°F., after which the vessel is opened. Steam aspirators are placed, and the vessel is blinded and tested for gas as above. About 4 to 6 hr. are required to cool the vessels in this manner.

Coke chambers are steamed from the bottom for an hour, after which water is introduced into the bottom of the chamber to cool the coke bed. About 6 hr. are required to cool a 13 by 50 ft. chamber. The atmosphere is tested for gas as soon as the top head is opened. No aspirators are used, for the chambers are decoked hydraulically, and it is not necessary for men to enter the vessel.

Furnace tubes. Topping heaters are normally "circulated" down. After cutting fires, cold residue is charged from a storage tank to the heater through the circulating manifold. The hot residue from the heater outlet returns through a dropout cooler to the storage tank. When the outlet temperature of the residue reaches 300°F., circulation is discontinued, and the heater tubes are steamed for 2 hr., after which they are opened for cleaning and inspection.

Cracking heater tubes are dropped out as soon as fires are cut, and steamed for 2 hr., after which they are opened.

Tanks. Tanks are pumped out through the waterdraw, followed by water to float the remaining hydrocarbon, and the liquid drawn to the sewer. Steam is introduced and continued until the tank is vapor free. Aspirators are placed in roof manways to induce ventilation. If B. S. is present, blower masks are used by men working in the tank until the sludge deposit has been shoveled out. All rafters and horizontal surfaces in tanks in sour naphtha or gasoline service are thoroughly cleaned to remove iron sulphide (which may be pyrophoric). On other tanks, cleaning is usually confined to the bottom of the tank, unless inspection work is to be done.

Fire hazards. Tube bundles in gasoline and naphtha service frequently contain pyrophoric iron sulphide. Fires from this source can prove very serious. Cases are known in which the tube bundle was completely destroyed by fires resulting from spontaneous ignition of sulphides. Water hoses played on the bundle as it is pulled from the shell will eliminate this hazard. The exchangers should, of course, be flushed with water before opening.

Tank fires have been known to be caused by the combustion of pyrophoric iron sulphide. Floating roof tanks are most susceptible, because the lowering of the roof as the tank drops to low gauge exposes tank wall surfaces to the atmosphere. The hazard can be reduced by maintaining roof seals in good condition.

Disposal of spent chemicals. In the refining of West Texas crude, sulphuric acid and caustic soda are utilized for sulphur reduction and H_2S removal. Disposal of the spent chemicals may prove to be a problem. Sodium sulphide solutions and acidic wastes should not be permitted to mix in the sewer system because of the release of H_2S that would result. One solution is the installation of a separate drainage system for spent caustic solutions. The alternate to this is to schedule drainage of chemicals to the sewer. In a typical system of this type, caustic wastes may be drained during the first 2 hr. of each shift and acid during the fifth and sixth hours. During the second and fourth 2-hr. periods chemical draining is prohibited. In these periods, the sewer system is washed free of chemical waste. This schedule should be modified to suit the particular conditions at any refinery.

Any mercaptans present in spent sodas should be removed before discharging to the sewer. This can be done by steam stripping the spent solution. Direct injection of exhaust steam into a packed or plate column is satisfactory. The vapors from the top of the stripper may be vented to a nearby heater for disposal.

In some cases, the discharge of sulphide spent caustic itself may be undesirable especially if the stream to which wastes are discharged is the source of supply of a domestic water plant. Small amounts of sodium sulphide are not serious, of course, but large amounts may impart an undesirable taste to the drinking water. If this situation exists it may be necessary to install neutralizing facilities for sulphide spent caustics. Acid sludge can be used as the neutralizing agent, thus converting the sulphide salts to sodium sulphate. The H_2S gas produced is vented to a heater where it may be used as fuel. The oil released from the acid sludge is recovered and used as refinery fuel. In operating this system, the aqueous solution from the neutralizer is maintained at ½ to 1 per cent free acid. Homogeneous lead lining is recommended for the neutralizing vessel, although a monel lined steel vessel is also suitable.

If the spent caustics contain appreciable quantities of acid oils (alkyl phenols) the effect on drinking water supplies becomes extremely serious, because phenols, after chlorination in water plants, are distasteful and may be detected in concentrations of one part in one billion of water. Neutralization of phenolic wastes is necessary in this case, and settling of the aqueous layer in lead lined tanks is recommended in order to eliminate all acid oils entrained in the weak acid prior to draining to the sewer.

Acid sludge can be disposed of in three ways: Burning under boilers, burning in sludge ponds situated well away from the refining area, and acid recovery units, which produce fresh acid for process use. The first two methods are used at this refinery. Burning of the sludge is carried out in a Duncan sludge burner.

★★★

SALT WATER DISPOSAL IN EAST TEXAS

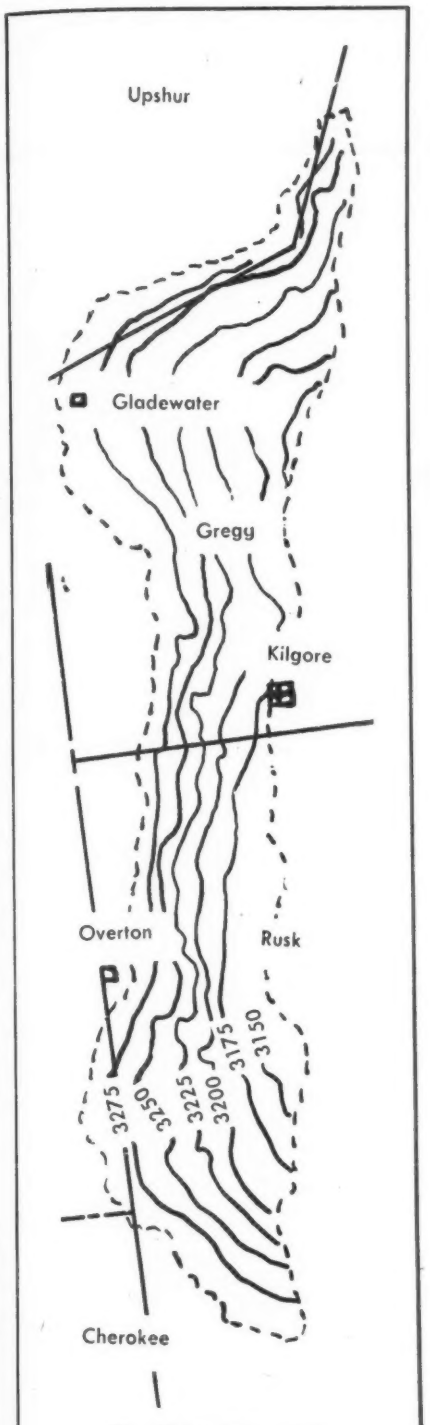

Fig. 9. Contours top of Woodbine sand.

The data and information contained herein has not been approved nor validated by the Topical Committee on Vocational Training of the American Petroleum Institute. It has been sponsored by the State Board of Vocational Education in Texas in cooperation with the East Texas Chapter of the American Petroleum Institute, and is based upon data and experience arising from current operations in the East Texas field and is intended for instructional purposes in that area.

Section B—Petroleum Reservoirs

From our previous discussions we have seen that oil and gas originate in buried sediments and migrate through porous strata. Commercial accumulations occur where structural or stratigraphic conditions prevent continued migration. These reservoirs can be most completely studied and understood when represented graphically. Two basic methods are used:

EXCLUSIVE

1. Contour maps that represent an areal view of the reservoir.
2. Cross-sections that show a side view of the reservoir and the enclosing rocks or sediments.

▼ **Contour maps.** A contour map is a device used for many purposes in the oil industry. Data commonly represented in this manner include the following:

1. Surface features (topography). Surface contours are lines of equal elevation and delineate the configuration of the earth's surface.

2. Subsurface structural feature. These contours are drawn through points of equal depth on a formation or bed beneath the surface. They are most commonly used to represent the top of a reservoir zone, and permit accurate definition of the reservoir limits in addition to its depth at any particular location. Furthermore, gas-oil contacts and oil-water contacts can be readily represented by this method.

Fig. 9 is a sketch of the East Texas field represented by contours drawn on the top of the Woodbine sand. The contour interval is 25 ft. and from this map, answers can be found to the following questions:

(1) In what direction does the Woodbine dip?

(2) What happens to the Woodbine sand at the north and south ends of the field and results in termination of the oil accumulation in these directions?

(3) How much does the Woodbine dip between the east and west sides of the field?

3. Reservoir thickness. Lines representing equal thickness are termed "isopachs." Such lines may be used to illustrate the gross or net thickness of an oil or gas reservoir. Fig. 10 shows the oil sand thickness in the East Texas field. What does the zero isopach line represent at the eastern limits of the field? At the western limits?

4. Lines of equal value to indicate pressure zones and potential productiveness are also of common use in the oil industry.

5. Laboratory exercise in contour mapping, Fig. 11, is a contour map of the "dome" that you will use in your classroom work. By standing directly over the dome you can see how the horizontal lines that encircle the dome are drawn to depict this type of structure on a geologic map.

We will assume that this is a buried dome and that the top contour line is 1100 ft. depth subsea. We will also assume the contour interval of 50 ft. On the horizontal scale, let 1 in. equal 1 mile on the dome.

Assume the gas-oil contact at 1175 ft. subsea, and the water-oil contact at 1225 ft. subsea.

(Continued on Page 184)

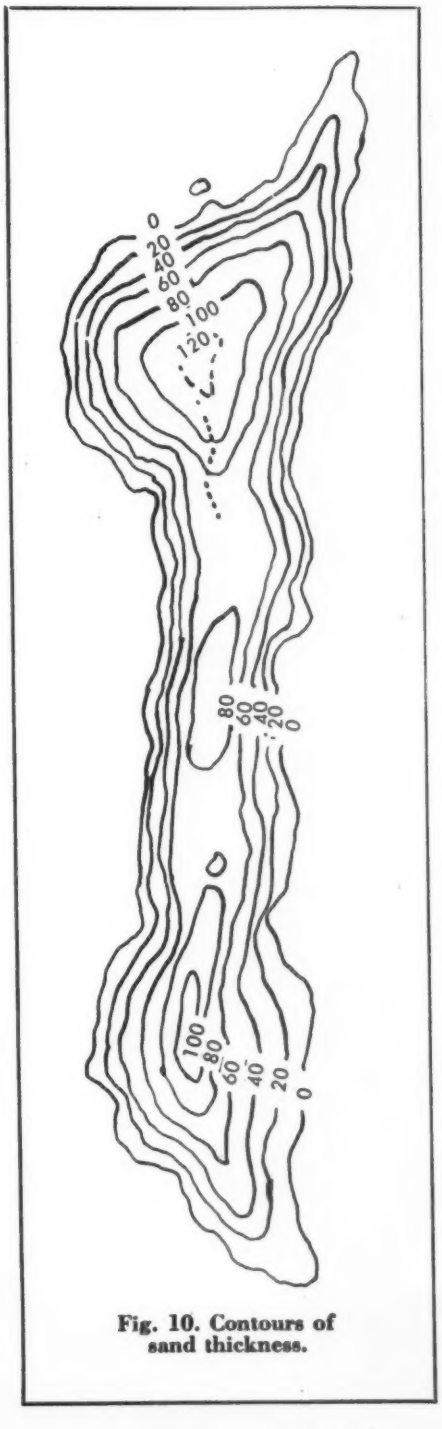

Fig. 10. Contours of sand thickness.

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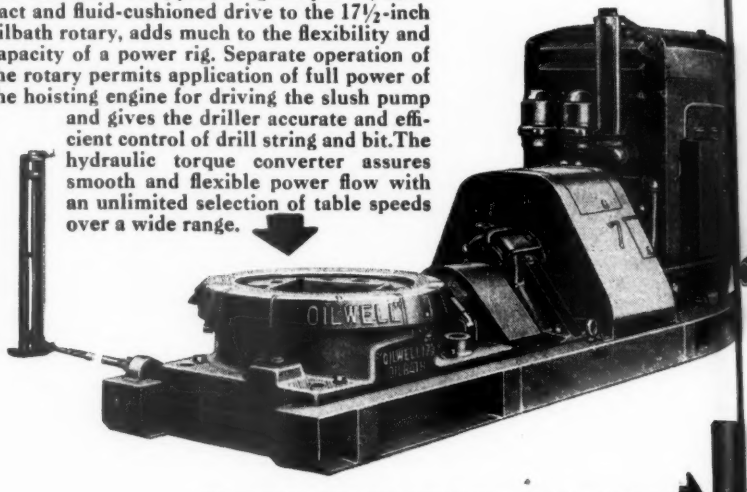

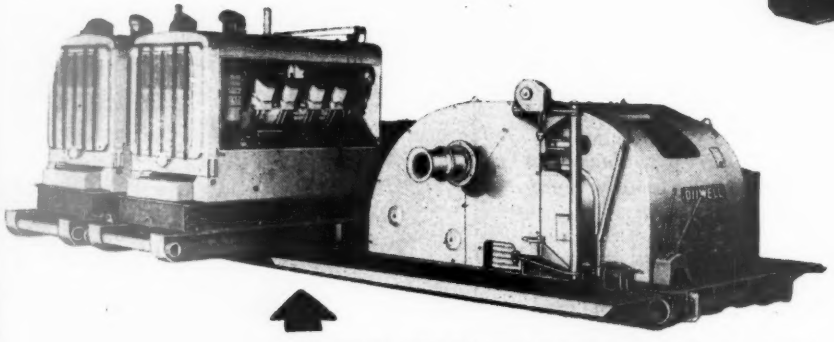

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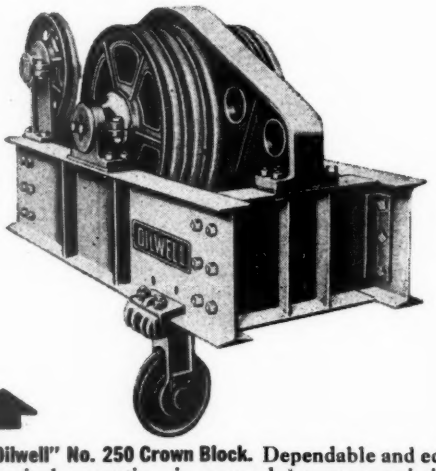

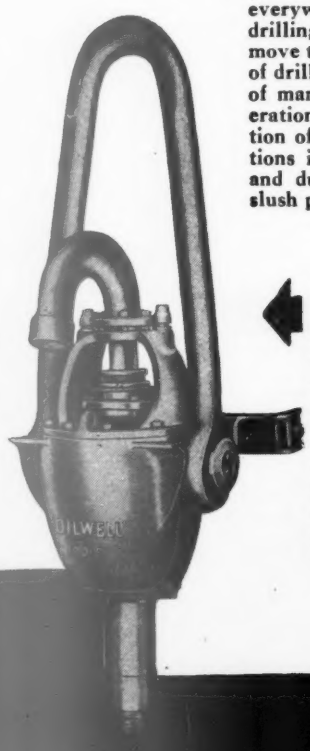

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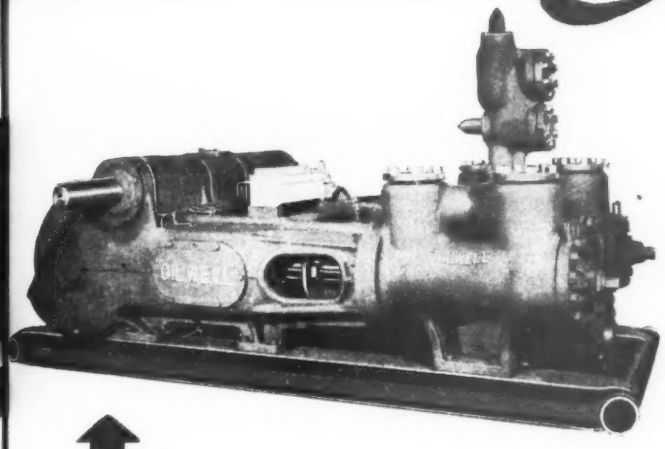

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"OILWELL"

(Continued from Page 181)

Exercise

1. Number all contour lines according to above data.
2. What is the approximate total height of the dome?
3. What is the approximate length of the dome in miles?
4. What is the approximate width of the dome in miles?
5. Shade the gas zone and the water zone on the map. (Do not shade the oil zone.)

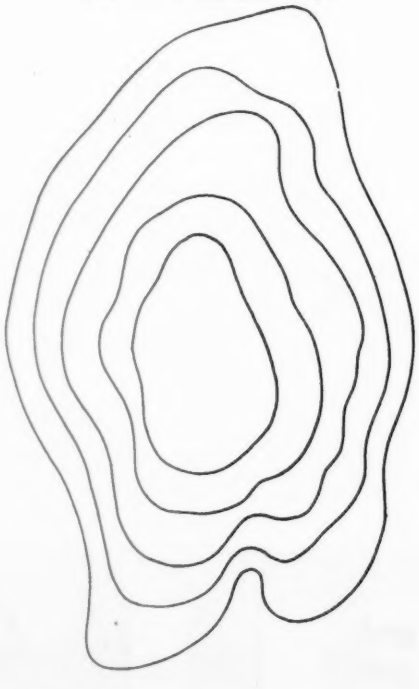
▼ **Cross-sections.** Although more data pertaining to an oil reservoir probably can be represented by means of a contour map than by any other method, the use of cross-sections is essential to any reservoir study. By use of these profiles through the reservoir details may be revealed that otherwise might escape attention.Where complex stratigraphic or structural conditions prevail cross-sections provide the most helpful means of understanding these problems.

Refer to Figs. 2, 3, and 4 (Page 68, September issue), illustrating the growth of an anticline and accumulation of oil and gas; Fig. 5, a cross-section of a salt dome; Fig. 6, an accumulation against a fault, and Fig. 7, a shore line accumulation.

Cross-sections illustrate variations in degree that are difficult to represent on a contour map. Thus, an explanation of differential water encroachment may be readily made apparent from a study of cross-section in cases where representation by contours is difficult. Such methods are particularly useful in explaining problems of water encroachment. (See Fig. 14.)

▼ **Principles of electrical logging.** Early geological exploration in the petroleum industry was confined to surface mapping. In any selected area the geologic section was worked out from surface outcrops and the established section

Fig. 11. A contour map.



Second installment, proceedings of vocational classes in salt water disposal. Others will be published in future issues.

served as a guide in exploration practice. Because in many areas geologic formations occur in the subsurface but do not outcrop it is apparent that conditions were often encountered that could not be readily explained. Thus the importance of subsurface geology in exploitation of petroleum reserves has long been recognized and progress in the field has been given valuable aid through micropaleontology, studies of cuttings and core examinations; however, the introduction of electrical well logs in 1933 probably provided the most outstanding achievement in this field.

Self-potential curve—this curve is a record of minute electrical currents that are generated between fluid in the bore hole and formation fluids. Two factors contribute to the generation of these currents: Electro-chemical effect and electro-filtration effect.

The self-potential curve offers a means of distinction between porous, permeable zones such as sands, porous limestones, etc., and relatively impermeable sediments such as shale. Consequently, the recorded curve is utilized primarily as a basis for recognition of formations and correlation of different layers.

Resistivity curves — resistivity is the unit resistance of a formation to the transmission of an electric current and is measured in ohms. The resistivity value at any depth is calculated by measuring the drop in electric potential between two selected points in an electric field set up by introduction of an artificial current. In its simplest principle the separation of the points between which the potential drop is measured may be considered as equivalent to the depth of effective penetration.

It follows, therefore, that with an electrode separation of 18 in. the zone of effective resistivity measurement would be a sphere with a radius of 18 in. As this exceeds the diameter of bore holes and because the fluid in the bore hole (mud) is homogeneous and possesses uniform electrical properties, the variations in electrical resistivity that can be recorded by raising or lowering the electrode container in the hole can be attributed to the effect of different beds of sediments.

The self-potential curve is recorded simultaneously with the resistivity values and the net result is (1) an S.P. curve that for general purposes may be considered as an indication of porosity, and (2) a resistivity curve that records the resistance of beds to passage of an electric current. As all rocks are poor conductors, the resistivity of any bed depends to a great extent on the amount, nature, and distribution of the fluid contents, especially water.

Most subsurface formations, with the exception of shallow sediments, are saturated with salt water. This fluid is an excellent conductor of electricity, and consequently zones carrying salt water record minimum values on an electric log. Oil and gas, on the other hand, are poor conductors and therefore record maximum resistivity values. It is apparent that because all oil and gas zones contain varying amounts of connate water, the actual value of the resistivity curve will be strongly influenced by the amount of water present.

The actual resistivity measured on the normal curve is affected by only a theoretically thin penetration of the formations encountered. Electric logging companies soon recognized the fact that mud invasion into the formations and thickness of beds might produce erroneous values, consequently two additional resistivity curves were developed that represent a greater penetration from the bore hole and escape the effect of mud invasion. These curves are generally called the 3rd or lateral curve and the 4th or inverse curve.

From the above curve discussion we may assume that under ideal conditions a porous sand will be recorded by an electrical log as a relatively high value on the left-hand side of the log and conversely, shales will be indicated by low values on the same curve. The thickness and depth of each bed can be read directly from the log. The resistivity curve opposite sands will record minimum values if the member is saturated with salt water, and maximum values if gas or oil is present. If the sand contains oil or gas underlain by salt water the resistivity curve will show an abrupt break from a maximum value to zero and the point at which this break occurs represents the water level for the reservoir.

Detailed studies are made of individual beds and formations penetrated in the well that is surveyed. In this manner characteristics of producing formations may be analyzed and the information gained will serve as a guide not only in determining completion practice, but also future remedial operations.

Electrical logs from all wells in a field serve as a basis for determining the size of the productive area, water levels, gas-oil contacts, and reservoir volume.

Electric logs have been run on about 1500 wells in the East Texas field and additional surveys of the sand section are currently being made on some wells when they are worked over. As the stratigraphic section from the surface down to the top of the sand is reasonably uniform, most operators make a detailed survey of the Woodbine section only. These surveys are initially made on a scale of 1 in. equals 2 ft. and are subsequently reduced to one-half to a scale of 1 in. equals 40 ft. These logs indicate shale breaks in the Woodbine section and also provide data relative to the

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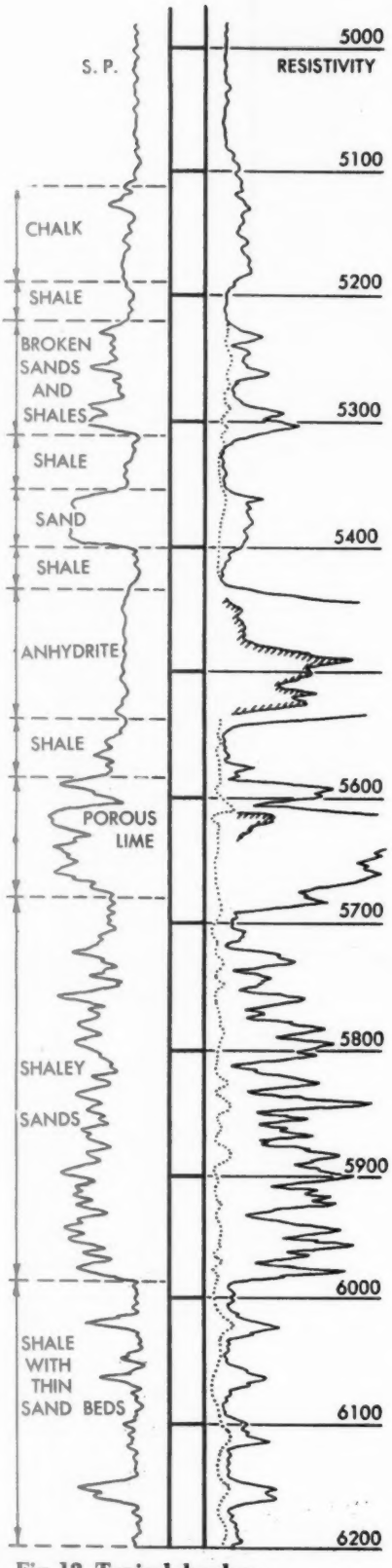
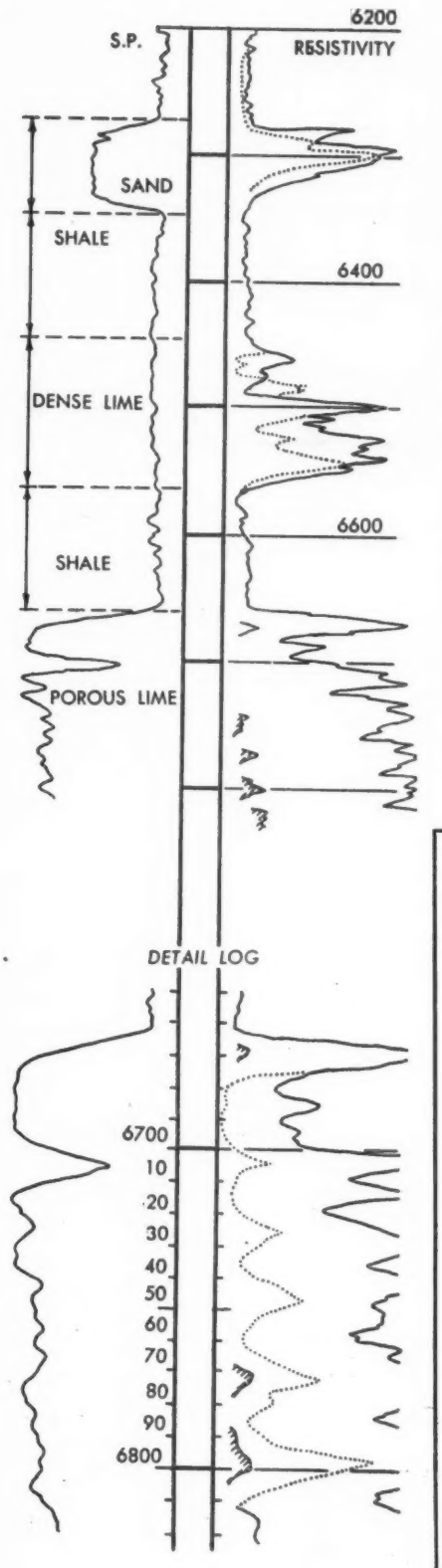


Fig. 12. Typical development of sediments as expressed by electric logs.



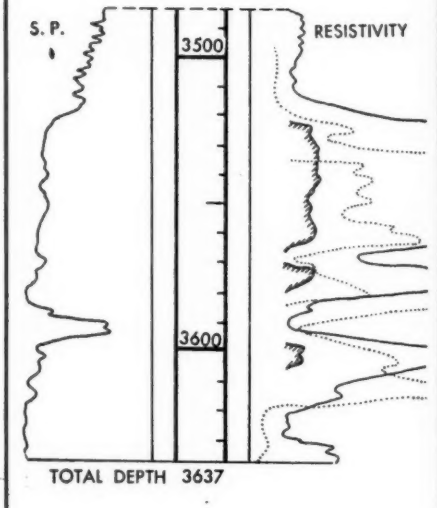


Fig. 13. Typical Woodbine sand. Section East Texas field.

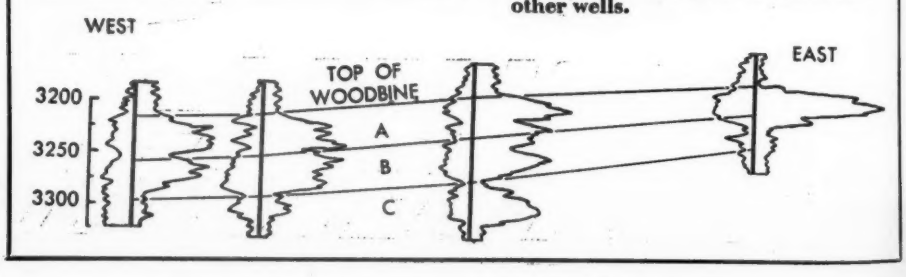


Fig. 14. Study of the Woodbine sand section in East Texas field. Correlation between 4 wells. Note evidence of water in well at extreme west and position of the indicated water level relative to other wells.

water level if the hole is bottomed below the oil-water contact. This is particularly valuable information especially in guiding workover operations.

In the case of salt water disposal wells drilled within the producing area of the field, it indicates the oil-water contact and the shale breaks in the water section. The selection of the casing seat is made on the basis of the electric log, it being necessary to establish the casing seat below a substantial shale break below the original oil-water interface.

Recognition of sand zones as identified by electrical logs is relatively simple because sand is the most common porous sediment encountered in wells in this area and the only other porous sedimentary bed with which it may be confused is limestone. On electrical logs sand beds are recorded by an increase in value on the self-potential curve. Maximum values are generally recorded where relatively clean sand beds are penetrated. Between minimum self-potential values (shales) and maximum readings, sands may be represented by any intermediate values as influenced by impurities such as shale. These impurities may be present as separate beds within the sand or may be mixed more or less uniformly throughout the sand bed. Thus, a sandy shale bed may show only a slight increase in value on the self-potential curve whereas a sand zone with streaks of shale will be developed on the electrical log as an alternating series of high and low self-potential values.

Porous limestones may sometimes be confused with sand beds when interpreting electrical logs; however, limestone

zones are invariably characterized by the presence of some dense non-porous beds, which are represented on electrical logs as intervals of decreased self-potential whereas the resistivity curve generally reflects an accompanying increase in value. By comparison, shales, which often occur in sand zones, exhibit minimum values on both self-potential and resistivity curves.

The presence of oil or gas in a sand will cause an increase on the resistivity curves. Salt water sands record low or minimum values. If a well penetrates a sand that is saturated with oil or gas that is underlain by salt water corresponding high resistivity values will be recorded in the upper part of the bed with low values in the section saturated with salt water. The break in the resistivity curve will then indicate the water level in the reservoir.

In Fig. 15 the water level is indicated at approximately 3578 ft. With an elevation of 298 ft., this places the water level at a subsea position of 3280 ft. In this figure note the development of the Austin chalk above the Woodbine sand between the depths of 3484 and 3537 ft. Likewise, note the self-potential curve, which indicates that the upper part of the sand is relatively clean with few impurities whereas below 3565 ft. it is broken or shaley.

In the well illustrated by Fig. 16 the water level is indicated at 3658 ft. (Elevation 363 ft.), 3295 ft. subsea. Note the lateral resistivity curve, which drops to zero almost immediately at the water level, whereas the normal resistivity curve is somewhat affected by invasion. Definite shale beds are shown at 3640 ft. and 3660 ft. Shales of this type are important in plug-back work because wells plugged back to a definite shale bed often result in further delay of water encroachment. ★ ★ ★

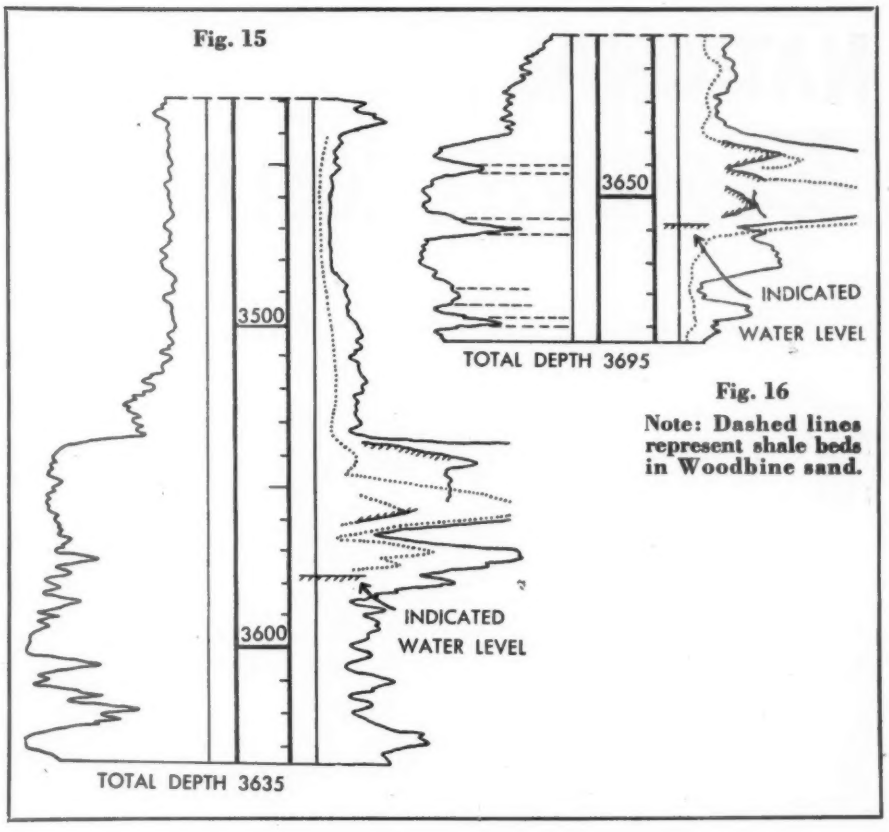


Fig. 15

Fig. 16

Note: Dashed lines represent shale beds in Woodbine sand.

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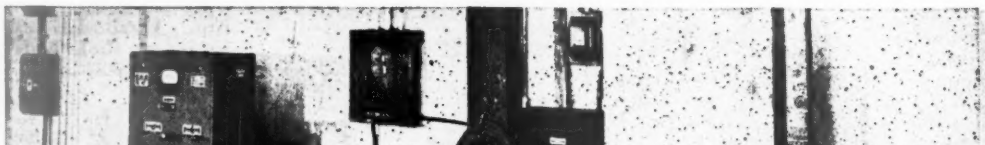
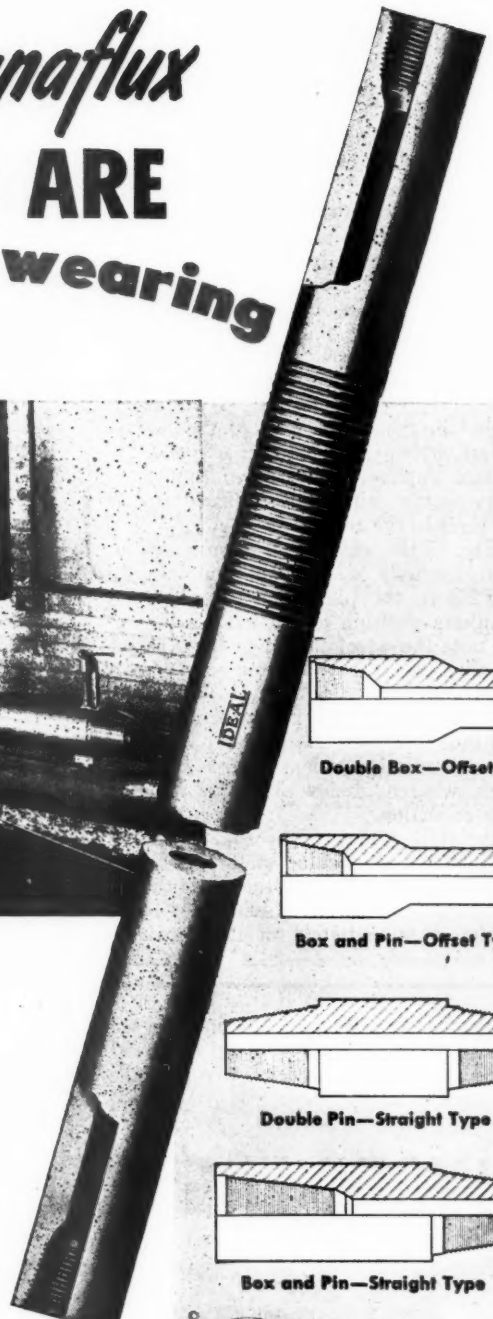
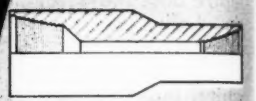
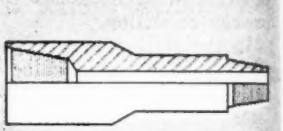






Double Box—Offset Type



Box and Pin—Offset Type

Double Pin—Straight Type

Box and Pin—Straight Type

THE Magnaflux Inspection Method is the most modern technical development yet devised for the detection of hidden flaws, cracks and seams in steel.

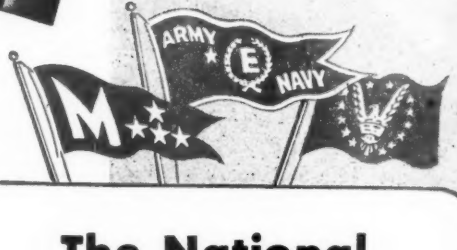
The underlying principles of the method can be stated in fairly simple terms: If a piece of steel is magnetized so that the magnetic field crosses its flaws or defects at an angle, local poles are developed at such defects. When Magnaflux powder or paste is brought into the vicinity, they are attracted and held at these local poles and form a pattern of the defect. By this method cracks can be discovered with their edges compressed so tightly they cannot be seen under a high-powered microscope, and when the correct procedure and apparatus is employed, cracks and seams can often be located at considerable distances below the surface.

Perhaps the most convincing testimonial to the value of Magnaflux testing is its universal adoption by practically all commercial airlines in the United States and Canada.

TYPES AVAILABLE

Although collars are generally furnished with API tool joint box each end, they may be furnished with other joints as specified. Types generally specified are shown at right. All standard tool joint boxes have joint sections long enough for several rethreadings.

Common field practice is to use two or more Type I collars on bottom of string, then reduce to the drill pipe size by the use of one Type 2 collar. NATIONAL can furnish alloy steel substitutes for connecting the various collars.



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General Sales Offices: Toledo, Ohio. Division Offices: Denver; Ft. Worth; Pittsburgh; Tulsa; Torrance. Export: The National Supply Corporation, 30 Rockefeller Plaza, New York, N. Y., U.S.A.; River Plate House, 12 South Place, London, E.C.2.

PIPE LINE COMPUTING CHARTS

By **W. F. MARTIN,** Texoma Natural Gas Company

EXCLUSIVE THE accompanying chart, Fig. 1, for making pipe line computations is based on the formula $Q = c\left[\frac{(P_1^2 - P_2^2)\,d^{5\frac{1}{6}}}{GTLm}\right]^{\frac{1}{2}}$

Where:

Q = volume of gas in M. cu ft. on a 16.4-lb. pressure base per 24 hr.;

T = absolute flowing temperature of 60° F. + 460, and

G = specific gravity of 0.700.

▼ **Chart construction.** The formula is rearranged thus:

$$Q/c\left(\frac{d^{5\frac{1}{6}}}{GTLm}\right)^{\frac{1}{2}} = (P_1^2 - P_2^2)\,\tfrac{1}{2}.$$

From the above, it can be seen that two special scales are needed, one for $c(d^{5\frac{1}{6}})\,\frac{1}{2}$ and the other for $(GTLm)\,\frac{1}{2}$. The former is titled "A", and is the Dividend Scale; the latter is titled "B" and is the Divisor Scale. When constructing these scales, in order to locate them conveniently on the chart, $(d^{5\frac{1}{6}})\,\frac{1}{2}$ and $Q(GTLm)\,\frac{1}{2}$ may be reduced or increased, so long as one is handled exactly as the other. In other words, each must have the same factor applied to it; this is obvious to a mathematician.

When the line "L" is drawn from the pivot point O, in the lower left-hand corner, through the intersection of A and B we are simply dividing A by B, and the result of this division, though not needed generally, is read on the horizontal scale titled E & F where L crosses the "10" horizontal line. This quotient is divided into Q by following the vertical line representing Q to its intersection with L. The result of this division, $(P_1^2 - P_2^2)\,\frac{1}{2}$, is read on the vertical scale titled C & D at the horizontal line that intersects the vertical line representing Q at L. For the sake of brevity and convenience, $(P_1^2 - P_2^2)\,\frac{1}{2}$ is called C, and for the same reasons, P_1 is called D, and P_2 is called F. C, D, and F represent the three sides of a right triangle. We will always have one side given, we arrive at another side, "C", as explained above, and from these two sides we establish the third. For instance, given C and F, the distance on L from its pivot point to the intersection of C and F is the hypotenuse of the triangle, or D, or P_1. (See Fig. 1.) If L were graduated with like graduations of the C & D Scale, P_1 could be read on L at the intersection of C and F. As it is not graduated, it is only necessary to mark L at this intersection, change it to a vertical position, and read P_1 or D at mark on the vertical scale.

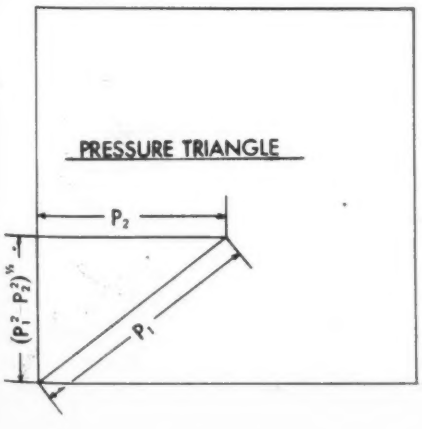
In order to have so much information on a chart of reasonable size, it is obvious that different values must be assigned to some of the diameter lines shown. The lines are numbered 1, 2, and 3, and these numbers are the keys to their values. The values for these numbers with respect to scale E & F are: For No. 1, MM. cu. ft.; for No. 2, 10 MM. cu. ft., and for No. 3, 100 MM. cu. ft. Such values appear under "Instructions" on the chart.

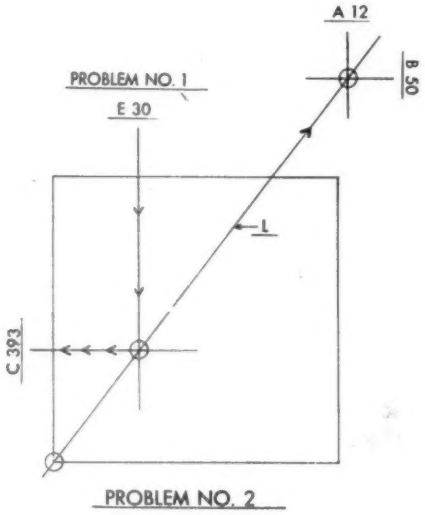
The values of C & D and F are always in hundreds when dealing with pressures.

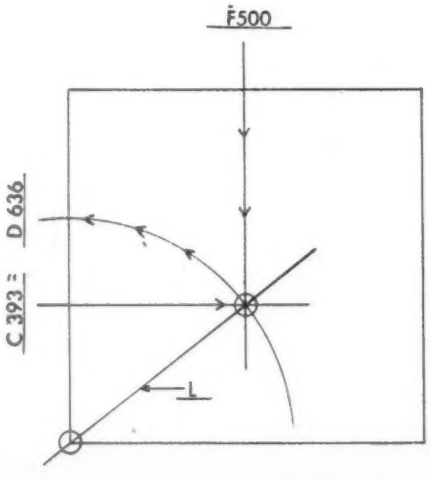
When using scales C & D and E & F for miscellaneous calculations, values will, of course, depend on what is being handled. These scales can be used in lieu of a slide rule, and as accurately.

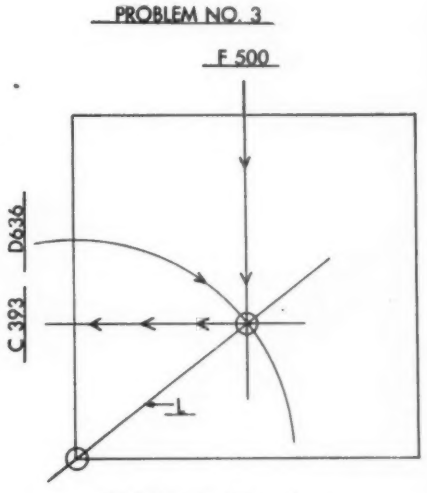
The only time that quotient A/B must be used is when applying factors to arrive at a pipe size not shown on the chart, or for a greater length of line than shown.

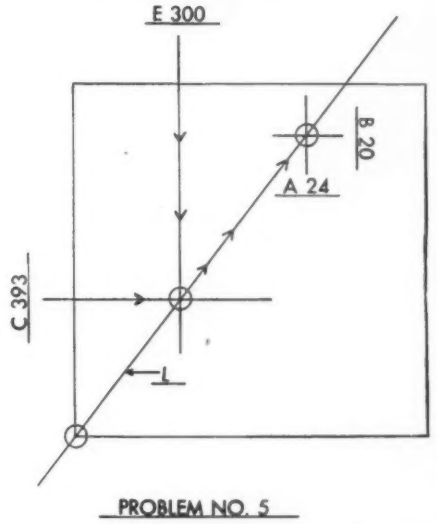
Factors for a change in diameter of pipe may be arrived at as follows and noted on the margin of the chart: $(d_1/d)^{8/3}$

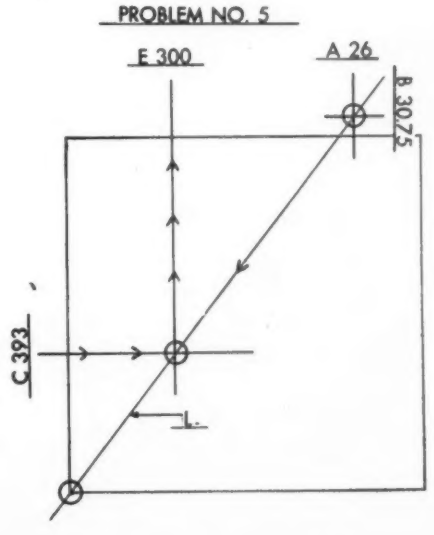












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d = shown, or base, diameter
d_1 = actual diameter.

Factors for a change in line length may be arrived at as follows:

$$\left(\frac{Lm}{Lm_1}\right)^{\frac{1}{2}}$$

Lm = length shown, or base length
Lm_1 = actual length.

These factors must be applied to A/B, and can be applied with the chart. Change L to corrected A/B and proceed as outlined herein.

▼ **What can be done with the chart.** The following problems are graphically solved on the chart, and reference is made thereto.

Problem No. 1:

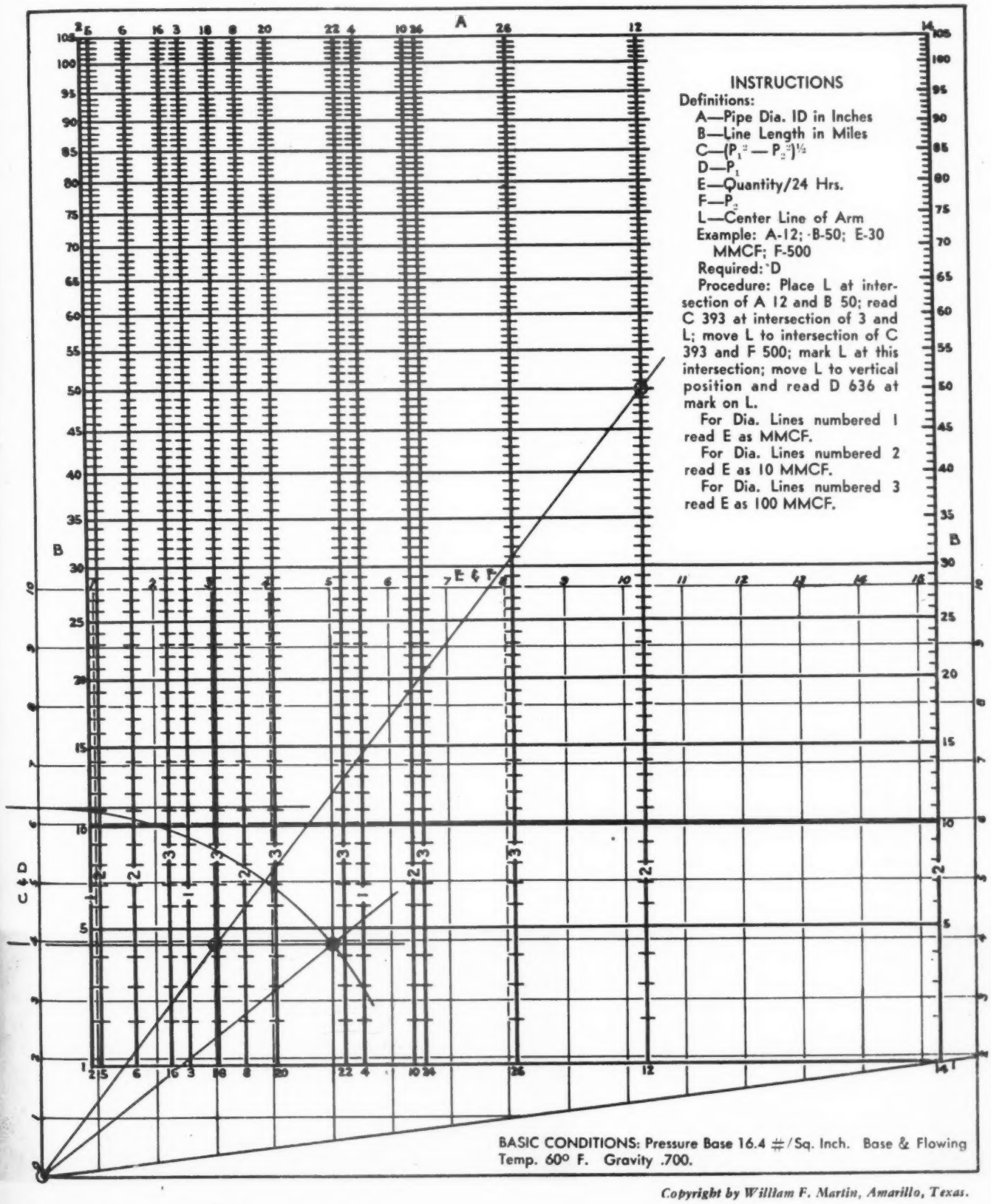
Given: Q, or E = 30 MM. cu ft.; pipe diameter, or A = 12 in., line length, or B = 50 miles.

Required: $(P_1^2 - P_2^2)^{\frac{1}{2}}$ or C.

Procedure: Draw L at intersection of A 12 and B 50, and note that E 3 intersects C 393 at L. $(P_1^2 - P_2^2)^{\frac{1}{2}} = 393$.

(Continued on Page 196)

FIG. 1. PIPE LINE COMPUTING CHART
Based on Weymouth's formula for gas flow through pipe lines


A
B
C & D
E & F
INSTRUCTIONS
Definitions:
A—Pipe Dia. ID in Inches
B—Line Length in Miles
C—$(P_1^2 - P_2^2)^{\frac{1}{2}}$
D—P_1
E—Quantity/24 Hrs.
F—P_2
L—Center Line of Arm
Example: A-12; B-50; E-30 MMCF; F-500
Required: D
Procedure: Place L at intersection of A 12 and B 50; read C 393 at intersection of 3 and L; move L to intersection of C 393 and F 500; mark L at this intersection; move L to vertical position and read D 636 at mark on L.
For Dia. Lines numbered 1 read E as MMCF.
For Dia. Lines numbered 2 read E as 10 MMCF.
For Dia. Lines numbered 3 read E as 100 MMCF.
BASIC CONDITIONS: Pressure Base 16.4 #/Sq. Inch. Base & Flowing Temp. 60° F. Gravity .700.

Copyright by William F. Martin, Amarillo, Texas.

then he thought to himself

"WHY WAIT 'TIL YOU'RE CORNERED?"

AT his recent reception in Washington, General DeGaulle and General Pershing were deploring the havoc of the war and hoping some good might result. DeGaulle remarked that perhaps Mahomet had something when he ventured the statement:

"Without war, the world would be in a condition of stagnation."

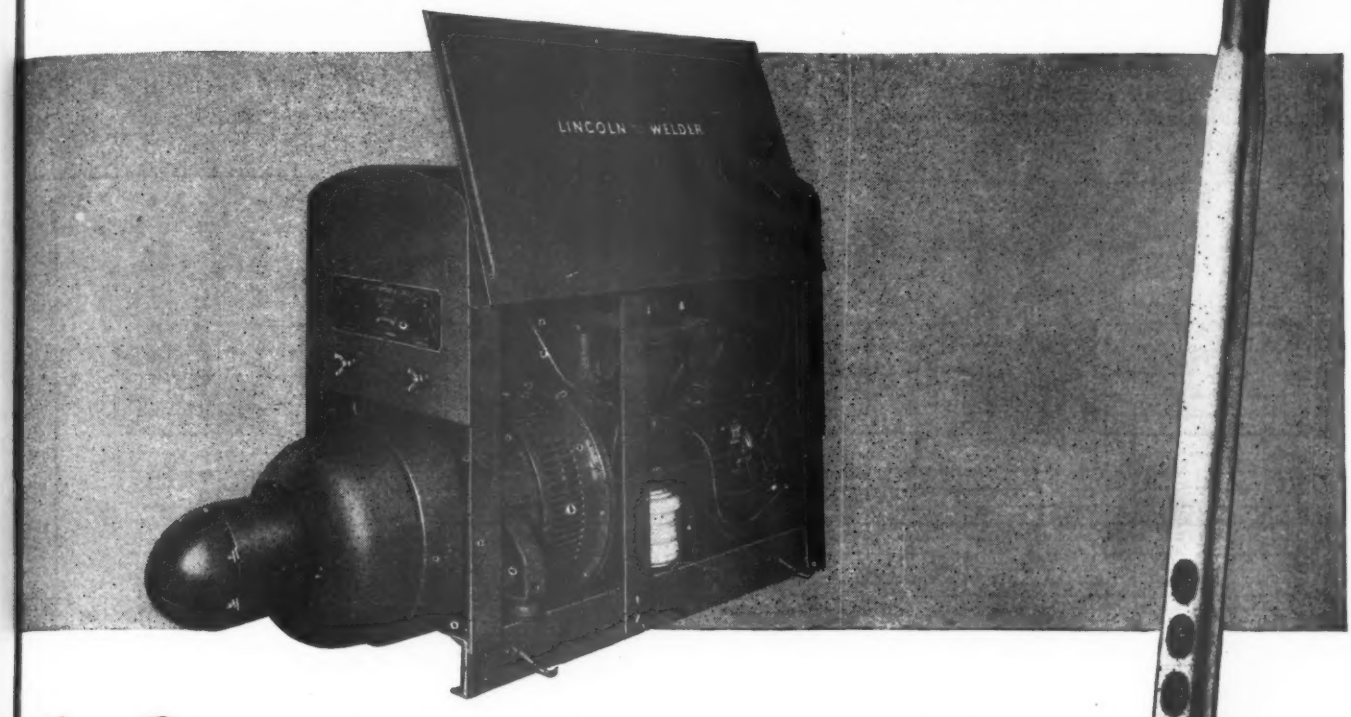
It is a sad commentary on human inertia that men must wait until the gun is jabbed in their ribs before they will stir themselves to great effort.

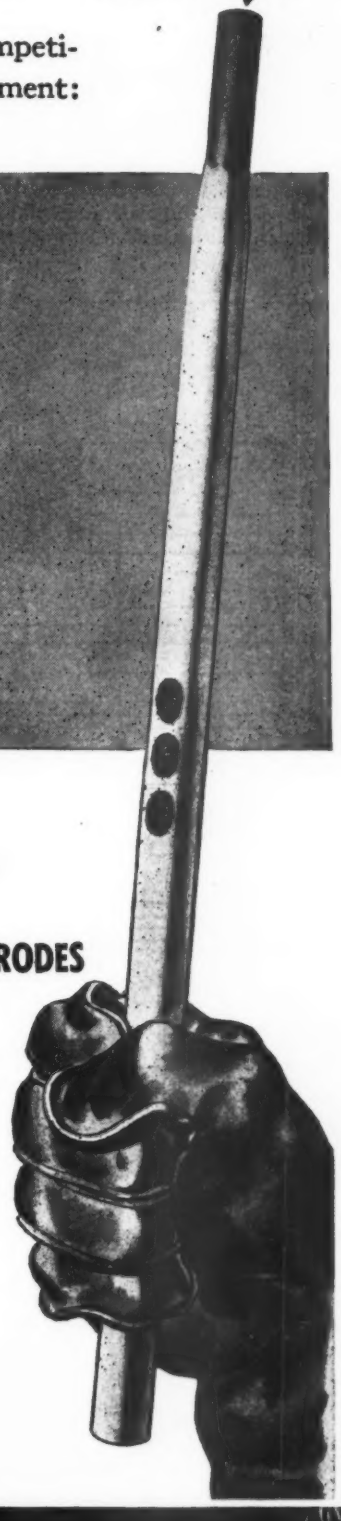
But it seems a fact that men usually wait for a crisis before they get bold and take hurried recourse to the best means for liberation.

Even today, some business men are waiting for the pointed guns of competition before taking action. And others . . .

"WHY WAIT 'TIL YOU'RE CORNERED?" *he says*

LOOK, GENERAL, how some are beating the gun of competition through recourse to this Lincoln Arc Welding equipment:





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Full details and procedures in "Weldirectory," Bul. 402. Free on request.

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America's greatest natural **recourse**

ARC WELDING

(Continued from Page 193)

Arrows indicate steps: 1 arrow is the first step; 2 arrows the second step and 3 arrows the third step.

Problem No. 2:

Given: $(P_1^2 - P_2^2)\,½$ or C = 393; P_2 or F = 500 lb.

Required: P_1, or D.

Procedure: Place L at intersection of the vertical line representing F 500 and the horizontal line representing C 393, mark L at this intersection, change L to vertical position and read 636 at this mark. P_1 = 636 lb.

Ordinarily, the two stated problems would be one, but the manner in which they are shown clearly explains the operation.

Problem No. 3:

Given: P_1, or D, = 636; P_2, or F = 500.

Required: $(P_1^2 - P_2^2)\,½$, or C.

Procedure: Draw L in vertical position and mark it at D 636. Change L to right until this mark intersects F 5. The horizontal line intersecting F 5 at mark on L represents $(P_1^2 - P_2^2)\,½$ or C. It is 393.

Problem No. 4:

Given: $(P_1^2 - P_2^2)\,½$ or C = 393; Q or E = 300 MM. cu. ft.; line length, or B = 20 miles.

Required: Size of line, or A.

Procedure: Place L at intersection of C 393 and E 3. Follow L to B 20 and note that it intersects A 24 at B 20. Size of line is therefore 24 in.

Problem No. 5:

Given: C = 393; A = 26; B = 30.75.

Required: Delivery per 24 hr., or Q or E.

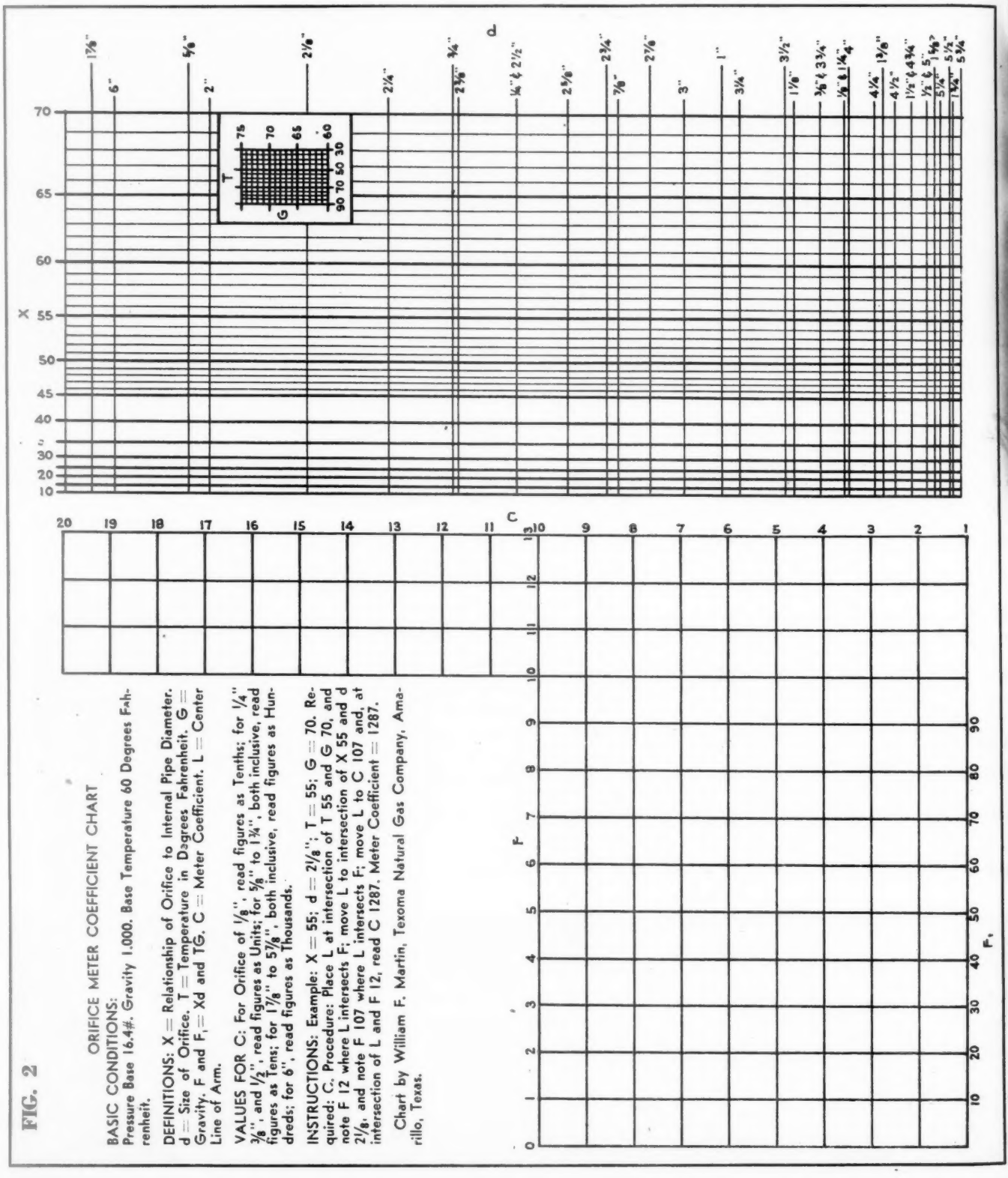


FIG. 2

ORIFICE METER COEFFICIENT CHART

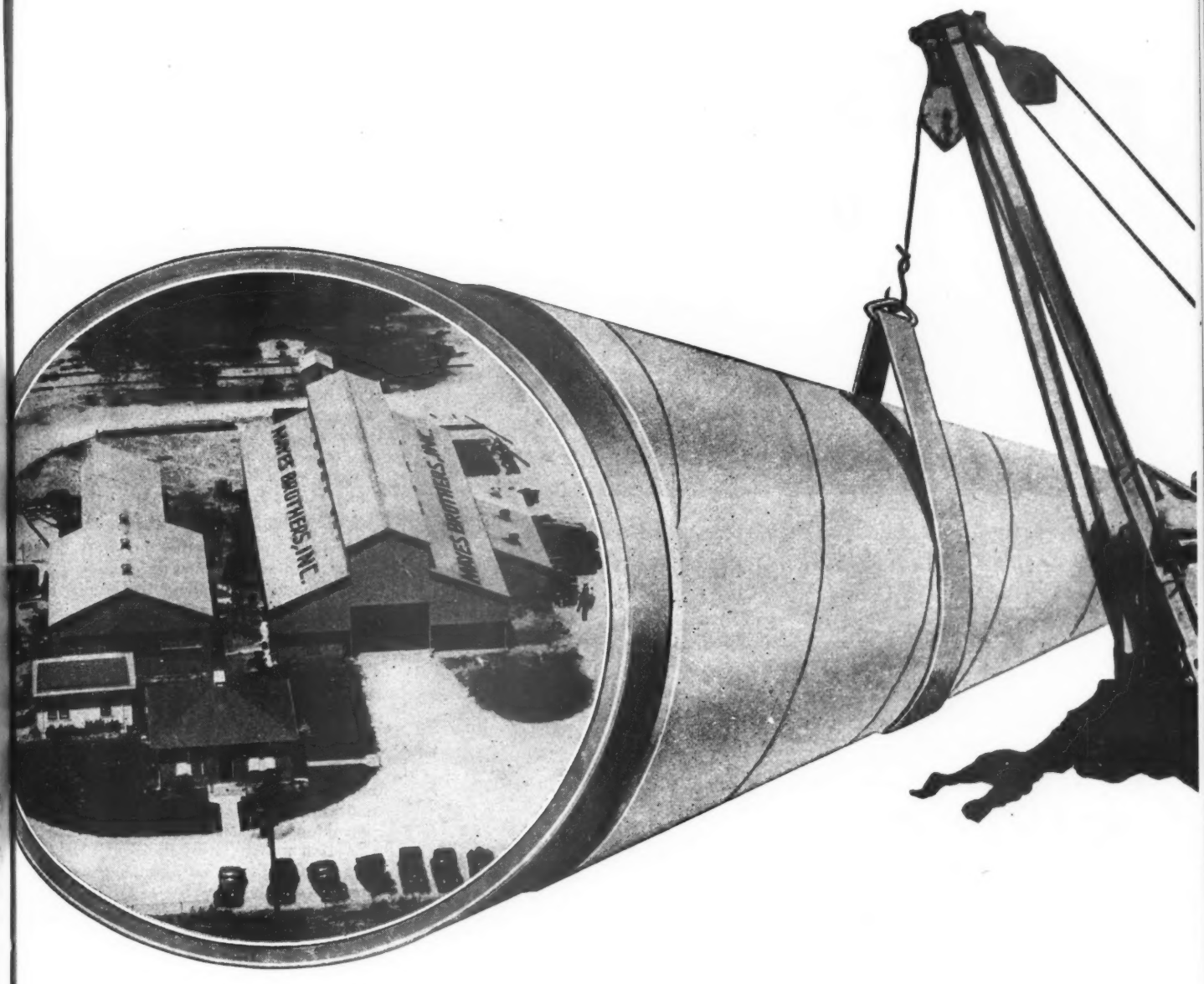
BASIC CONDITIONS:
Pressure Base 16.4#. Gravity 1.000. Base Temperature 60 Degrees Fahrenheit.

DEFINITIONS: X = Relationship of Orifice to Internal Pipe Diameter. d = Size of Orifice. T = Temperature in Degrees Fahrenheit. G = Gravity. F and F_1 = Xd and TG. C = Meter Coefficient. L = Center Line of Arm.

VALUES FOR C: For Orifice of ⅛", read figures as Tenths; for ¼" ⅜", and ½", read figures as Units; for ⅝" to 1¾", both inclusive, read figures as Tens; for 1⅞" to 5⅞", both inclusive, read figures as Hundreds; for 6", read figures as Thousands.

INSTRUCTIONS: Example: X = 55; d = 2⅛"; T = 55; G = 70. Required: C. Procedure: Place L at intersection of T 55 and G 70, and note F 12 where L intersects F; move L to intersection of X 55 and d 2⅛, and note F 107 where L intersects F; move L to C 107 and, at intersection of L and F 12, read C 1287. Meter Coefficient = 1287.

Chart by William F. Martin, Texoma Natural Gas Company, Amarillo, Texas.



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For gas gathering lines and natural gasoline plants, it will pay you to utilize the double-duty service of Naylor Pipe. Though light in weight, Naylor features an exclusive Lockseam Spiralweld structure that enables this distinctive pipe to handle jobs normally requiring heavier-wall pipe. The Spiralweld truss assures extra strength, leaktightness and safety under pressure, and its greater resistance to collapse makes Naylor ideal for vacuum service. This double-duty performance is obtainable in no other light-weight pipe.

Check These NAYLOR Performance Features

- Light weight saves steel.
- Easier to handle.
- Cuts installation time.
- Stronger, leaktight, safer.
- Accurate diameter.
- Holds true cylindrical form.
- Handles jobs normally requiring heavier-wall pipe.
- Saves maintenance.
- Saves money.

Sizes from 4" to 30" in diameter with all types of fittings, connections and fabrications.

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Procedure: Place L at intersection of A 26 and B 30.75. Follow L to its intersection with C 393. Vertical line intersecting C 393 at L represents delivery per 24 hr. It is 3, and since A 26 is a No. 3 line, delivery per 24 hr. is 300 MM. cu. ft.

▼ **Summary.** To sum up, the following remarks are made.

With L at specified A and B, a specified E will touch L at the required C. C is the base of the pressure triangle. A specified F is the altitude of this triangle. When L is placed at the intersection of C and F, it becomes the hypotenuse of this triangle, and the distance, measured along L from zero to this intersection, represents D. With L at the intersection of specified C and E, the size of line, or A, will be indicated where I intersects a specified B, or length. With L at specified A and B, the delivery, or E, will be indicated where L intersects a specified C.

▼ **Orifice meter coefficient chart.** Fig. 2 was prepared for use in obtaining an orifice meter coefficient corrected for gravity and temperature. The chart and instructions contained thereon are self explanatory. ★★★

Simplified procedure

Deputy Petroleum Administrator Ralph K. Davies has called attention to the simplified procedure for the procurement of materials and the export of those materials to foreign users engaged in petroleum industry activities.

Action was taken by the War Production Board, at the recommendation of the Petroleum Administration for War with the approval of the Foreign Economic Administration, as claimant agency for materials to be used in foreign countries. It was accomplished by amending WPB Priorities Regulation 9.

Priorities Regulation 9, as amended, accomplishes the following:

1. Formally authorizes the use of a project form (Form WPB-3649.1) for construction with a material cost in excess of $10,000.

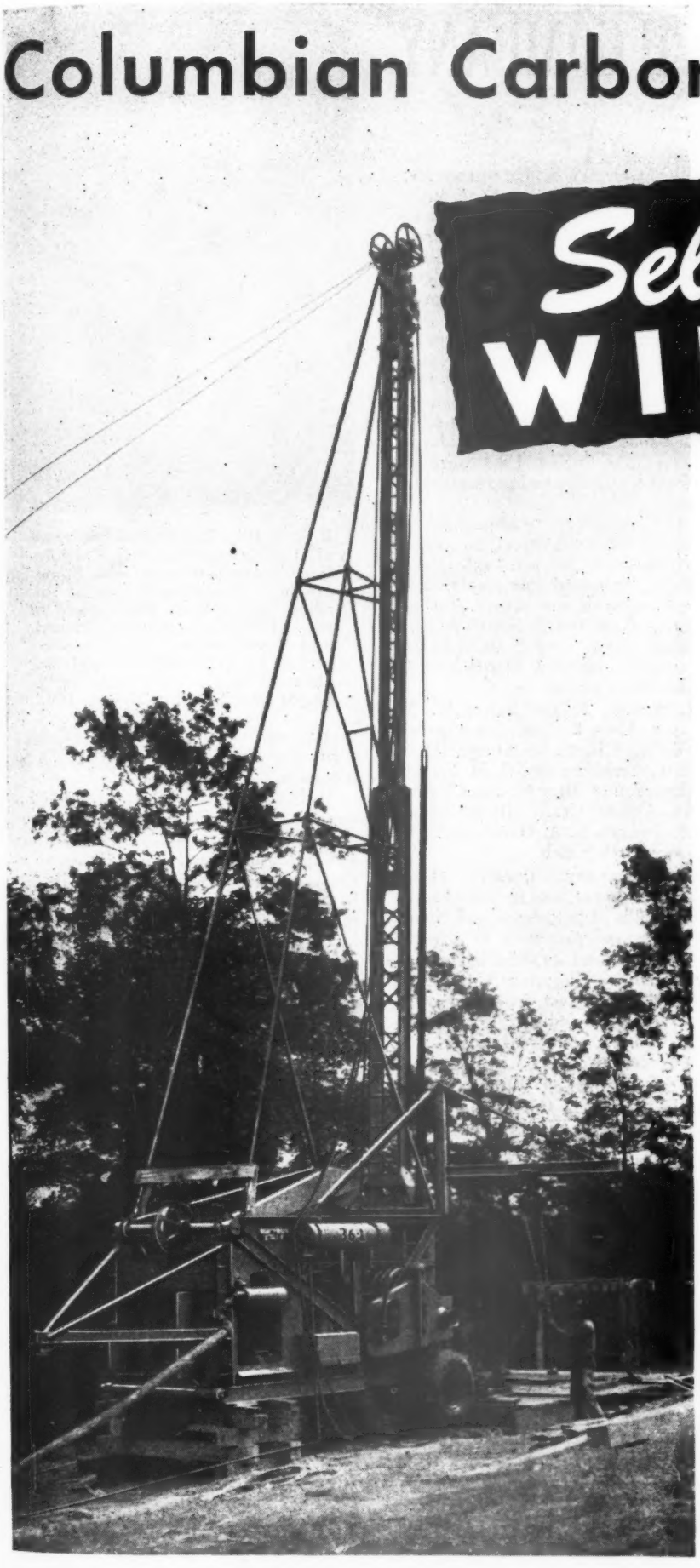
2. Authorizes the use of blanket preference ratings in obtaining material for maintenance and repair and for production operations provided the material is not listed on Schedule I of PR 9. This may be done by foreign petroleum operators as soon as they have received program letters from PAW. (These ratings place the foreign operators in parity with domestic operators. Program letters will serve much the same function to the foreign operators as PAO-11, PAO-12 and PAO-15 governing the domestic industry.)

3. Limits the use of blanket filing, as well as the limited filing under WPB-743, to materials for maintenance and repair purposes, operating supplies, materials for production operations, and materials for use in projects having a total material cost of $10,000 or less.

4. Requires the filing and specific approval of a pre-control form (Form WPB-743) to procure certain critical materials.

Columbian Carbon Company

Selects a WINNER



Speed . . . mobility . . . versatile performance to pay dividends on any job, whether drilling, tailing-in, fishing, servicing, cleaning-out, or swabbing — Columbian Carbon Company wanted these features in a spudder for its West Virginia operations.

They found them all, and more, in their first Bucyrus-Erie 36-L, bought in 1940. The 36-L's ability to do everything well, added to its operating ease, all-around toughness, and quick, easy setting-up convinced Columbian Carbon that they had truly picked a winner. That's why they have added six more Bucyrus-Eries to their equipment list.

Let Columbian Carbon's experience be your guide to spudder needs. Look over the Bucyrus-Erie 36-L and 24-L spudders — find out what they can do for you on your oil field work.

K-48

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OIL FIELD SPUDDERS OF TOMORROW

ESTABLISH RESEARCH COMPANY

CREATION of a new petroleum research company is announced by H. D. Collier, president of Standard of California.

Known as the California Research Corporation, the new company's primary purpose is: To unify and place still more resources at the disposal of Standard's tremendously expanded program; to improve present products used by the army and navy; and to devise new weapons and processes.

For the future, Standard plans California Research as a bridge to reconversion from wartime to peacetime operations. It will be the responsibility of the organization to develop means whereby war processes and plants may be utilized to make postwar jobs and to provide industry with new and more efficient products.

Ralph A. Halloran, president of California Research Corporation, joined Standard as a chemist. Since then he has been with the producing department in the oil fields, and has been in charge of experimental cracking plants. He was named manager of the research and development department in 1926, which position he held until his recent promotion.

California Research has taken over the functions of Standard's patent department and its research and development department. Indicative of the importance of the new organization to the war effort is the fact that 95 per cent of Standard's research efforts during 1943 were on United States military and governmental projects.

The new company, headquarters of which are at 200 Bush Street, San Francisco, will be a wholly-owned subsidiary. R. G. Follis, Standard vice president in charge of research and manufacturing, is chairman of the board, and R. A. Halloran, now manager of Standard's research and development department, is president. Other officers are:

J. N. Adams, F. L. Craise, W. N. Davis, and Alois Kremser, vice presidents; Ewing Sibbett, secretary; H. D. Armstrong, treasurer, and G. M. Foster, assistant secretary. Directors are: Follis, Halloran, Adams, Craise, Davis, Kremser, A. L. Lyman, G. A. Davidson, C. E. Finney and R. G. Smith.

The new company will carry out research, development, and technical service in the fields of petroleum and chemical products and processes. It directly serves Standard and its subsidiaries, including Oronite Chemical Company, which was formed last year to market the wide variety of industrial chemicals made possible by the increasing versatility of petroleum products.

With the removal of war pressures, California Research Corporation also will be available for the solution of special industrial problems. Its three laboratories are located at Richmond, El Segundo, and Whittier, California.

R. G. Follis, chairman of the board of California Research Corporation, began his career with Standard as an office boy before he finished high school. He worked in the engineering, refining, research and development, and manufacturing departments before being elected vice president and a member of board of directors in 1942.

The new company marks another important step in Standard's development of the field of industrial chemistry. Spurred by war's demands, petroleum and its derivatives now go into synthetic rubber, plastics, synthetic textiles, fertilizer, medicinal drugs, germicides, paints and lacquers, office appliances, household aids, furniture, and many other products that hold high prospects for maintenance of an expanded American economy.

★ ★ ★

Home of the California Research Corporation, planned to speed victory and to serve as a bridge to peacetime reconversion activity.

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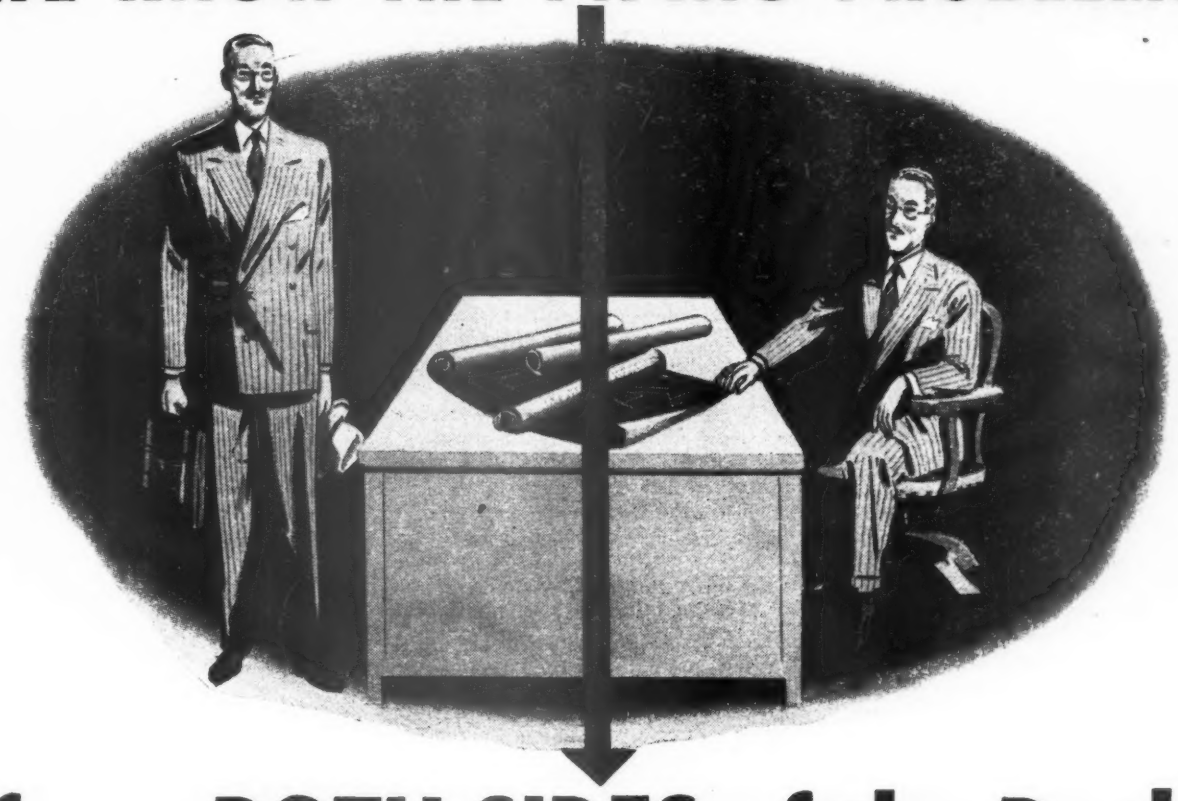

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Midwest not only fabricates piping for all purposes, but also operates an experienced contracting department that will deliver to the customer a completely installed piping system—ready for operation. Consequently, we have a clear view of piping problems from both sides of the desk.

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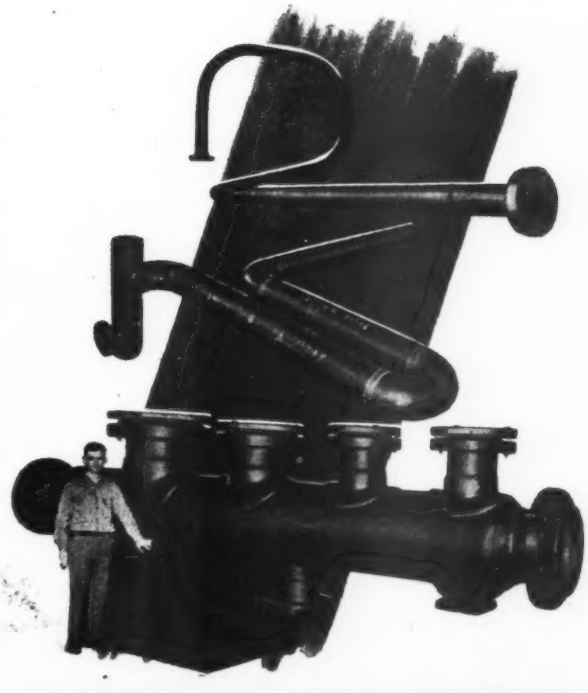
Midwest has four modern pipe fabricating plants strategically located to serve you . . . whether you need a simple bend or piping for an entire plant completely erected and ready for operation.



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Piping Fabricators and Contractors

PORTABLE AMPLIFIER FOR LOCATING WATER IN GAS LINES

By **FRANK H. LOVE,** *Managing Editor*

EXCLUSIVE UNITED GAS PIPE LINE COMPANY has been most successful in the use of a portable amplifier to locate water in its lines. The equipment, designed by one of its engineers, D. E. Stearns, is also used as a pipe locator and as a means of following pipe line scraper runs, which sometimes result in the stoppage of a scraper and consequent difficulty of finding the lost equipment.

The unit, shown in accompanying illustrations, is a 3-tube high resistance input, push-pull amplifier, using two 1G6-GT tubes and one 1G4-GT tube. The grid of one triode section of a 1G6-GT tube serves as the input to the amplifier, the section being resistance-coupled to the other triode section of the same 1G6-GT tube. The second section of the 1G6-GT tube is transformer-coupled to the 1G4-GT tube, which in turn is push-pull transformer-coupled to the input grids of the second 1G6-GT tube. The output of the second 1G6-GT tube is fed to the primary winding of an output transformer whose secondary feeds into either a decibel meter or into a set of earphones.

When the instrument is used as a pipe locator, energy is picked up by means of a small air core induction coil connected to the input grid of the first tube. When the instrument is used to amplify vibrations, as is done when locating water or pipe line scrapers, a standard vibration pickup unit is plugged into the input of the instrument and thus connected to the input grid of the first triode section. The plugging jack is of such nature that it cuts the air-core pickup coil out of the circuit when the vibration pickup unit is being used.

The output of the amplifier normally is connected to the sensitive meter, but if it is desired that the output be transformed into sound, a set of earphones is plugged into an appropriate jack that disconnects the meter in order to utilize all available output energy to actuate the phones.

The instrument uses a 1½-volt dry cell as a filament current supply and two midget 67½-volt batteries connected in series as a B supply for the tubes.

All transformers are of the midget plug-in type. Volume control is achieved by means of a potentiometer connected to the input grid of the second section of the first 1G6-GT tube.

In cities, where close differentiation between parallel lines is unnecessary, the instrument may be used as a pipe locator without the need for a signal generator. This is because induced currents are produced by power lines. Outside of cities, however, a source of energy must be utilized to place a signal on the pipe line.

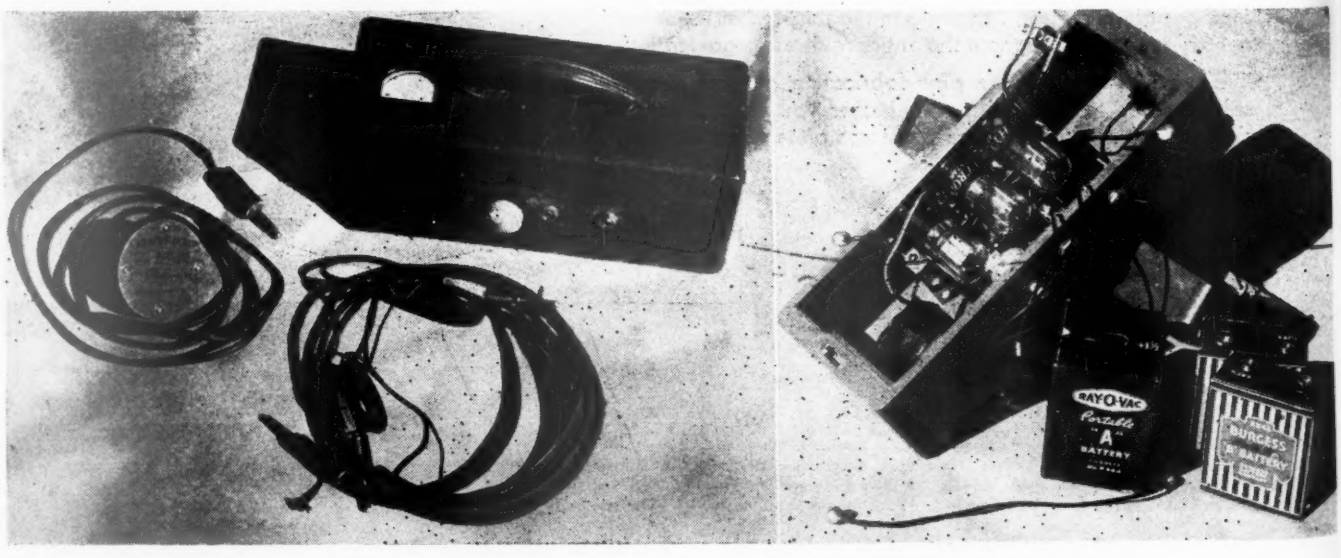
In listening for surging fluids in a pipe line a ¼-in. rod is driven into the earth until it contacts the pipe. The vibration pickup is then attached to the upper end of the rod by means of a small collar. This hookup results in the transfer of any vibration in the pipe line, such as is produced by surging fluid, to the vibration pickup, which transforms the mechanical motion into electrical energy and this is fed into the amplifier, thus increasing the volume and indicating the disturbance either on the meter or through the earphones, as desired.

When any other connection to the pipe is available, such as a blowoff riser, the vibration pickup may be attached to it instead of the ¼-in. rod and the same results obtained.

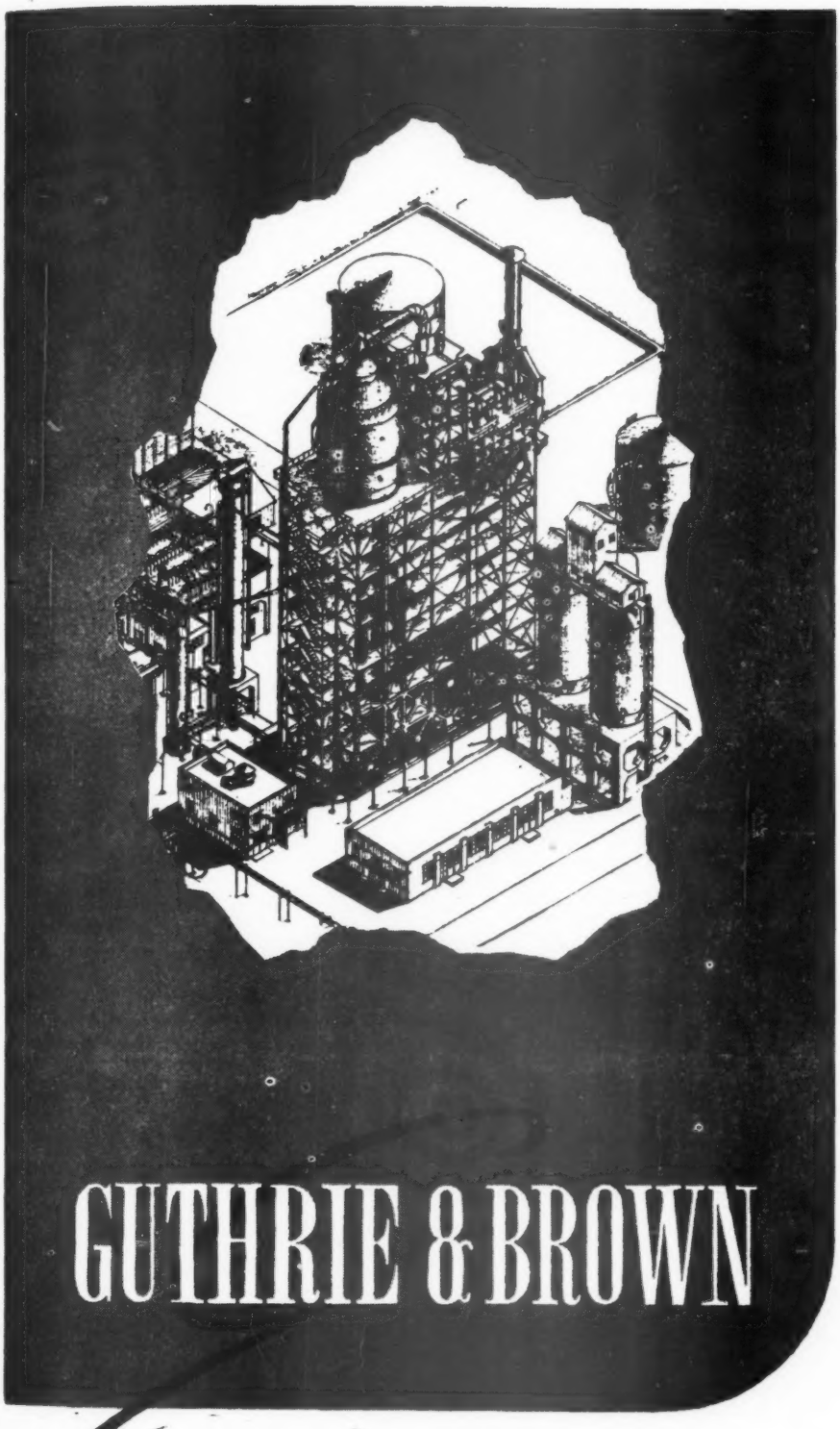
In some instances it has been found desirable to enclose the pickup unit in a small lightweight box in order to exclude airborne sounds, which sometimes are of a nature or intensity sufficient to interfere with the sounds being sought.

When the instrument is being used to listen for the motion of a pipe-line scraper it has been found that such movement can be heard for a distance of several miles if the point of observation is in the downstream direction from the scraper. If the instrument is placed on the upstream side of the scraper the noise produced by the movement of the scraper is substantially overshadowed by the noise produced by the flow of gas through the valve being used to bleed gas into the section of line for the purpose of propelling the scraper.

As mentioned, to date the greatest success in the use of the instrument has been for locating water or other fluids in pipe lines. When used for this purpose an efficiency test is run on lengths of line varying from 5 to 10 miles. A marked drop in pressure will reveal resistance to flow and indicate the general location of the interfering fluid. Use of the portable amplifier makes the exact spot of the collected fluid a relatively simple matter, as the movement of the fluid can be heard for a distance of approximately one-half mile. This method obviates the practice of tapping lines at points of suspected water collection, many of which taps prove to be unnecessary. ★ ★ ★



Exterior and interior views of the portable amplifier for locating water in gas lines. The equipment also has other uses, such as following scraper runs and locating line pipe.



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IT'S THE GLAMOR THAT LURES THEM

By **ERNESTINE ADAMS,** Assistant Editor

DIVERSE businesses have turned their eyes and some of their profits to the oil industry, which may be signs of the times or an indication of trends. The conclusion first reached, however, is that the search for oil is as tempting as when the railroad conductor, "Colonel" Drake, put what money he had—$200—into an oil company.

The glamor girl of the industries may be restrained to a standard of respectability after 85 years but she hasn't lost her fire and fascination. Few of the newcomers who are paying court to Miss Petroleum have made much headway. Just encouragement enough comes their way to hold to the skirts of the seductive wench who has attracted all kinds to her train.

There is John B. Hawley, Jr., president of Northern Ordance, Inc., Minneapolis, who has switched millions of dollars from munitions making to wildcatting. He drilled 21 dry holes before he saw any black gold of his own. Now he has producers in Ohio, Montana, and Texas — maybe elsewhere by the time this is in print because his drilling campaign is on the heavy side. Whether the millions will multiply or vanish is part of the lure of wildcatting.

The connection between beer and petroleum may be elusive but a brewing company is said to be the most successful neophyte in the oil business. Oil and gas wells in Oklahoma and Ohio have increased the income of the Peter Fox Brewing Company, Chicago, during the last year and the president, Frank G. Fox, believes they will make more for the firm next year.

After twelve years of participating in the oil business, The North American Car Corporation has no such report to give. The president, W. M. Spencer, said that thus far oil and gas properties have not contributed importantly to earnings. Production from wells in Kansas, Texas, and Montana, including one whose potential is 4000 bbl. daily, makes small return in comparison to the operation of the company's fleet of tank and refrigerator cars.

OTHERS who have felt the urge to search for oil have not had time to test their luck. O. G. Harp, Shawnee, Oklahoma, one of the largest poultry and egg processors in the country, is drilling his first wildcat. Mount Vernon Car Manufacturing Company of Pittsburgh, which has an active drilling campaign in Ohio and Mississippi, claims to be the first freight car manufacturer to include gas and oil production. Nu Enamel Company has made its initial oil venture in Texas and has two producers so far.

Movie stars are called to an industry as kaleidoscopic as their own. Arlene Judge and Charles Butterfield this spring joined with Ralph Stone, a car dealer in Nevada, to form a company that has been drilling for oil in Oklahoma.

DOES this influx of new names mean anything beyond a tribute to the lure of the oil industry? The fact that all the newcomers are in the exploration and wildcatting end of the industry, where chances of success would make a slot machine operator blush, makes that one reason seem adequate. The idea has been advanced that corporations are cutting their tax rate by spending money on oil tests, but this proves unfounded upon serious examination. Unreasonable oil losses on financial reports are not calculated to gain the confidence of stockholders or investors; success would logically bring a greater proportion of taxes than ever.

On the other hand, the entry of outside business hints at optimism on its part that is not entirely shared by the oil industry. Those within have been molded into a government pattern and worked at forced speed until it has seemed doubtful at times that the industry would ever be free again to pursue its own course toward progress and profit. Discouraged, oil men have been selling holdings while firms from other industries bought. The new companies are not novices in successful business and their belief in the future of the petroleum industry should be heartening to oil men who have worked long and hard for the war effort.

Only drawback to the universal attraction that the oil business holds is that the Administration feels the same tug and gives indications of wanting to adopt Peaches Petroleum.

HOWEVER, oil men who have thought about it put the welcome sign out to brewers and movie stars, egg men and munitions makers. If they are successful they will add to the glories of the industry; if they fail they have had their adventure. Right now they are demonstrating that smart business men in other industries believe in that old glamor girl—Petroleum. ★ ★ ★

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MODERN LUBRICATING OIL PLANT AT MARCUS HOOK

By **P. D. BARTON,** Sun Oil Company
Assistant Chief Engineer

EXCLUSIVE THE Sun Oil Company has just completed and placed in operation a new plant for producing high viscosity index oils of special qualities by a combination of several refining sequences operated continuously. The plant as a whole includes stock preparation by the vacuum distillation of long residuum to reject undesired low boiling oils; the solvent extraction of the vacuum reduced crude for control of paraffinicity; the dewaxing of the paraffinic fraction; the combination refining and filtering with Super-Filtrol and simultaneous vacuum distillation for the control of viscosity and flash point of the finished bright stock and neutrals, and finally the continuous blending of several components for finished lubricating oil specifications running directly to packages or other shipping facilities.

The unit is designed for extreme flexibility in type of stock charged, and range of viscosity, viscosity index, flash, fire, pourpoint, and other pertinent qualities. In changing from one stock to another or from one grade of product to another grade on the same stock, continuity of operation is obtained by the means of large capacity surge tanks between units. That is, the dewaxing plant may be processing an oil at the end of a run for several days before it is necessary to accept a different stock being produced by the solvent extraction unit. Means are also provided in each operating unit for rejecting off-specification products without interfering with the overall plant continuity.

High viscosity index oils having special qualities made in unit designed for extreme flexibility—capacity is 14,600 bbl. a day.

A feature of the plant as a whole is the convenient arrangement of the various operating units, which are all operated in conjunction under the same supervision. A control laboratory for simple routine tests is situated within the plant and an intercommunication system makes coordination a very simple process.

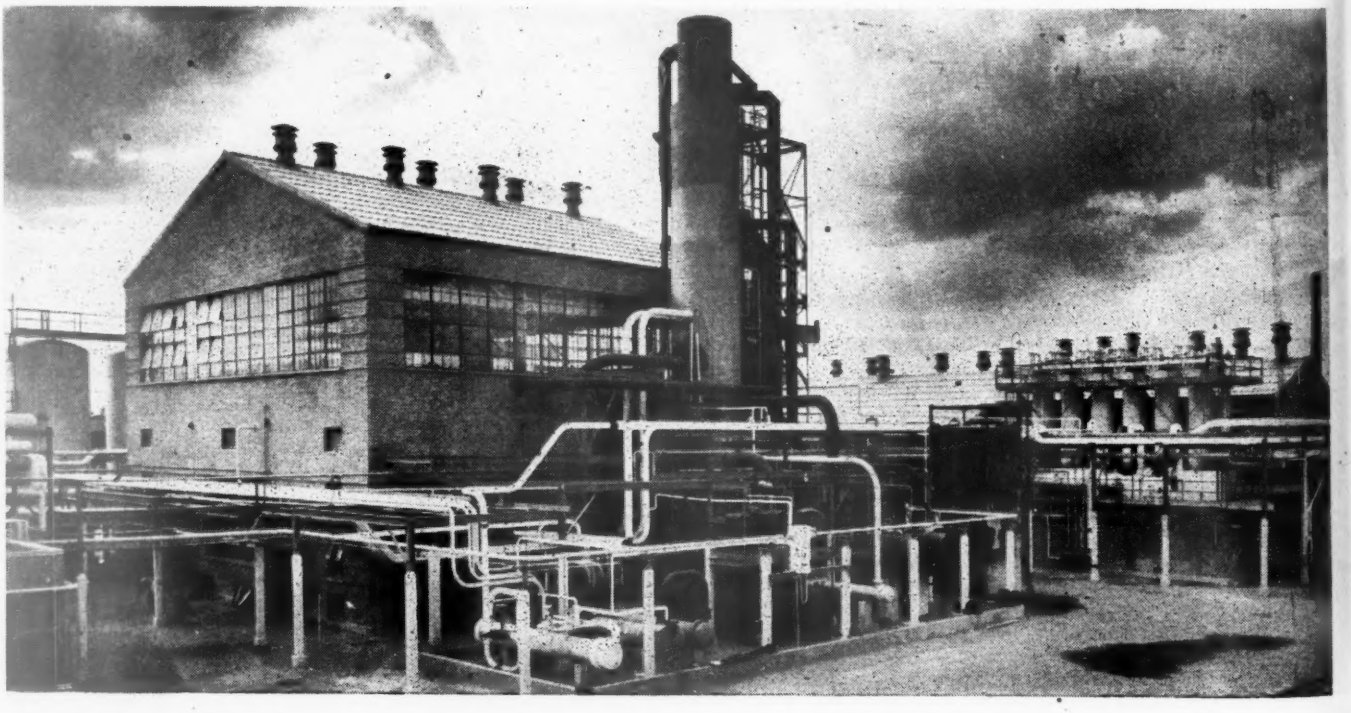
For the present this plant will be devoted exclusively to products essential to the conduct of the war, such as aviation grade and heavy duty lubricating oils. Other special products will continue to be produced in existing units utilizing Sun's Mercury vapor process followed by other treating and refining processes.

The new unit is designed to process up to 14,600 bbl. per day of charge to the vacuum distillation unit, the crude oil supply being drawn chiefly from Mid-Continent and Gulf Coast sources. A description of the sequence of operations in the various plant units is outlined below, the units being discussed in the order of their operation.

1. *Vacuum distillation charge unit.*
2. *Duo-Sol extraction unit.*
3. MEK-*benzol dewaxing unit.*
4. *Dewaxed oil rerun unit, Filtrol fractionation process.*
5. *Blending and packaging unit.*

▼ **Vacuum distillation charge unit.** The charge stock consists of tower bottoms from crude units, Plant 11, units 1, 2, and 3, and Plant 9, unit D, it being possible to take any combination of these units depending upon the charge rate desired. When making aircraft oil, it may be necessary to run all 4 units in order to obtain the charging capacity of 14,600 bbl. per stream day of reduced crude. The bottoms from those sources come from exchangers at a temperature of about 250°F. and because of fluctuation in rate due to bottom tower level control operation, it is necessary to provide a surge tank ahead of the vacuum unit charge pump.

The charging pump discharge stream is divided into two portions, one being conducted through the tubes of the vapor exchanger situated on top of the vacuum tower, the other passing through



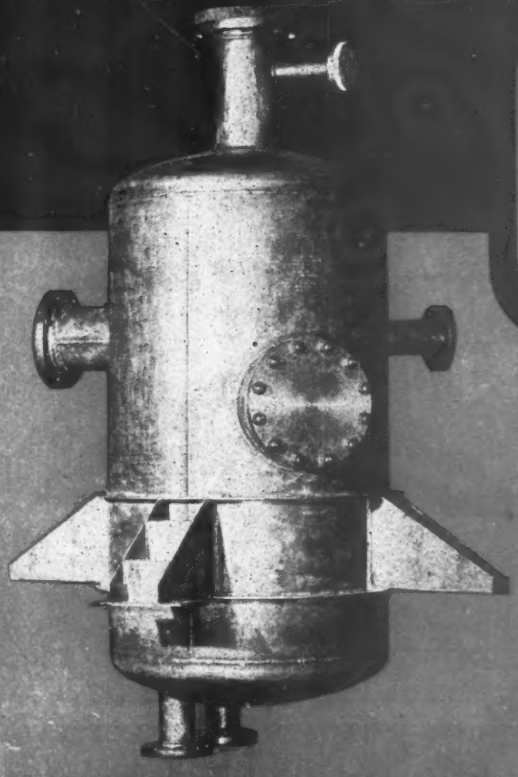
Firing building in lower left corner, solvent tank in back, 14-2 combination pump house filter building in center, 4 compartment flue gas and filter feed tanks next, and flue gas holder at right. Center foreground, cold solvent flue gas and slack wax exchangers and chillers, extreme right ammonia condensers, chiller compressor building.

STAINLESS VESSELS BY

SINCE 1918

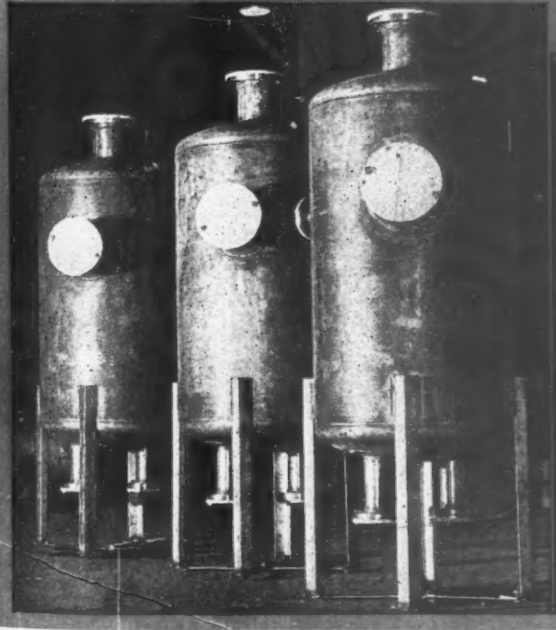
BEAIRD

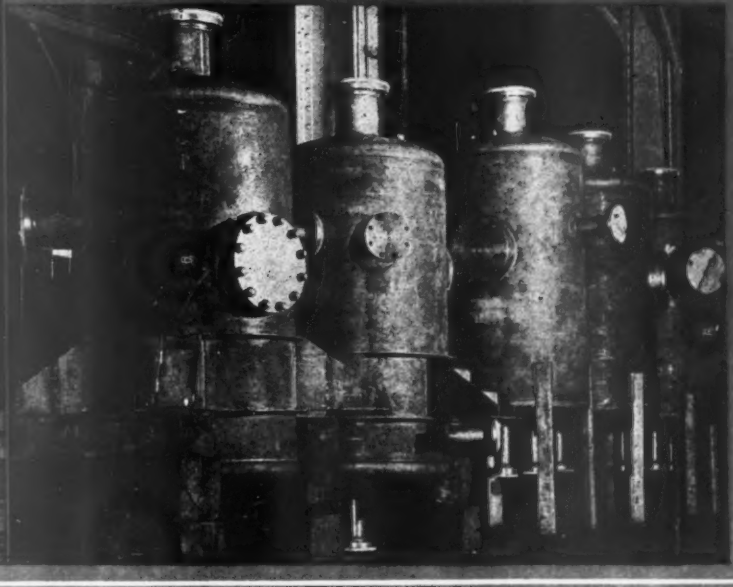
SHREVEPORT



Vessels of stainless steel and other alloys are being fabricated by Beaird for service where high corrosion or extremely low temperatures are factors. These vessels are made to exacting specifications. Many of them are built to operate at sub-zero temperatures. Welds meet all the required Charpy impact tests at —150 degrees F.

Highest quality welding, rigid inspection and 26 years of experience in steel design and fabrication go into every Beaird vessel. ASME or API-ASME code construction.





THE J. B. BEAIRD COMPANY

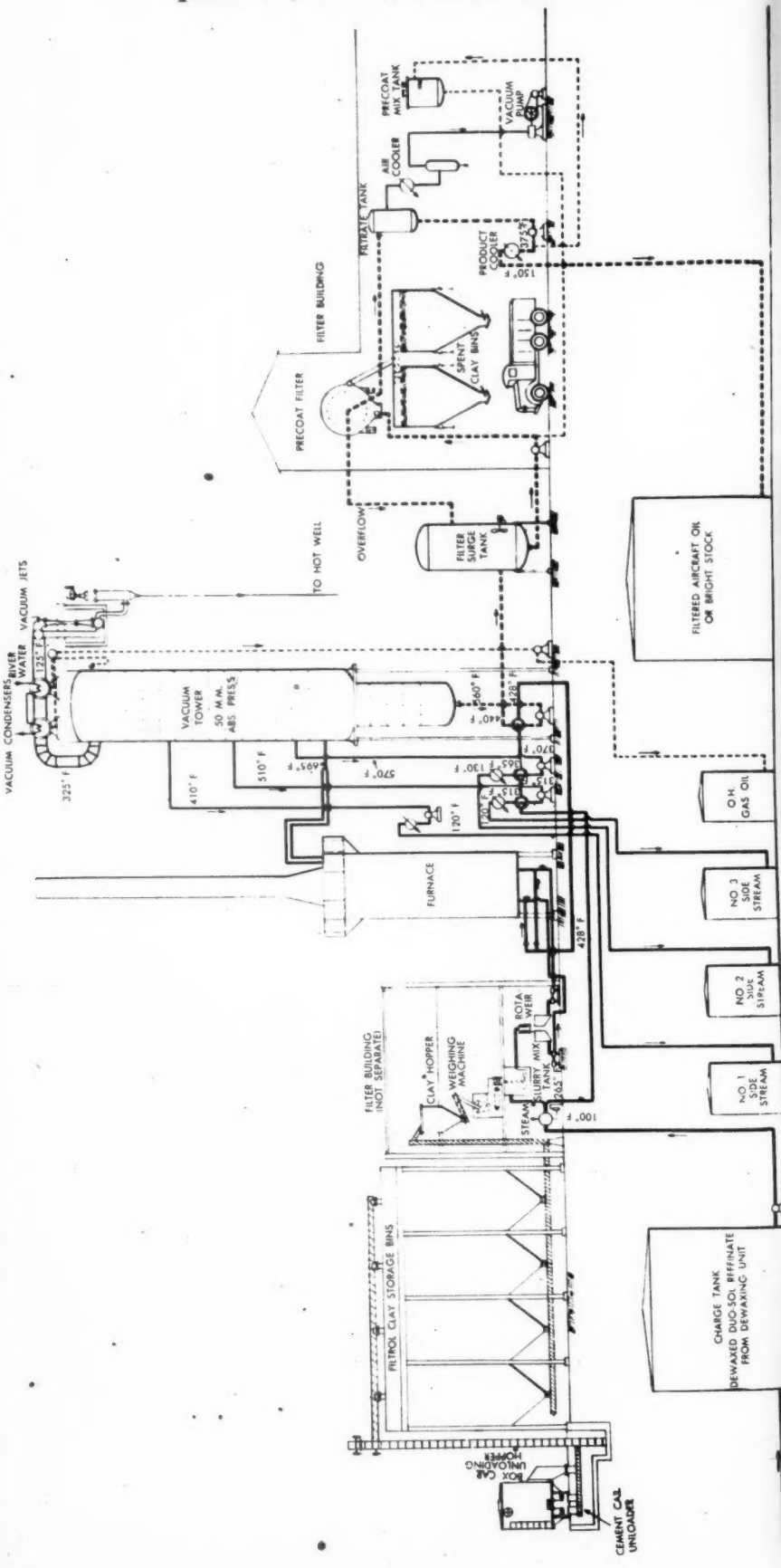
6300 ST. VINCENT AVENUE — SHREVEPORT, LOUISIANA

the tubes of the bottoms heat exchangers, the split being manually controlled to obtain approximately the same outlet temperature of both portions. The temperature of the charge is raised from an exchanger outlet of about 460°F. to a furnace outlet of 715°F., at which temperature it enters the vacuum flash tower. The vacuum tower is operated for the retention of desired lubricating oil fractions and the elimination of gas oil (and light lubricants when operating for the production of aircraft oils), the flash-point of the bottoms being controlled by the introduction of a small quantity of stripping steam. The bottoms pass through the shells of the heat exchangers and coolers and are conducted to the Duo-Sol unit charge tanks. The overhead vapors from the vacuum tower pass in series through the vapor exchanger and water-cooled vacuum condenser. The uncondensed steam and uncondensed gases and vapors are eliminated through the combination barometric condensers and vacuum jets. Condensed gas oil is withdrawn in two streams, one from the vapor exchanger, which also supplies reflux, the other from the vacuum condenser. These streams are cooled separately and are composited in a surge tank. When operating for the production of aircraft oils, the overhead distillate is too heavy to be classed as fresh gas oil, being considered suitable only for heavy oil cracking plant charge. It should be pointed out that a side stream can be taken from this tower, making available a fresh gas oil product overhead; when operating for the production of motor oils, the overhead product will meet fresh gas oil specifications.

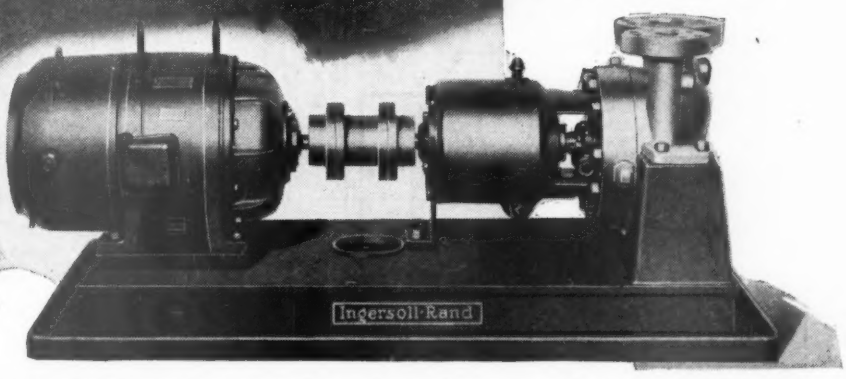
▼ **Duo-Sol extraction unit.** Reduced crude derived from the vacuum tower operation conducted in Plant 11, unit 5, is accumulated and stored hot (200-225°F.) in considerable quantity, two 24,000 bbl. tanks being provided for this purpose. It is important that a constant charge quality be maintained to get the best results from the Duo-Sol extraction unit. The object of the Duo-Sol treatment is to take advantage of the selective solubility of 2 non-miscible solvents, thereby concentrating the paraffinic hydrocarbons in one layer and the naphthenic hydrocarbons in the other. The paraffinic solvent is propane; the naphthenic solvent is called "selecto." Selecto is composed of varying proportions of phenol and cresol, depending somewhat upon the type of oil being treated and the final result desired. The relatively large difference in gravity (selecto 1.05 sp. gr., propane 0.509) between the two solvents facilitates the operation that is carried out in a series of extractors in which intimate mixing is followed by a low velocity separation.

In operation, the charge oil is introduced at a controlled temperature (100 to 130°F.) and at a pressure sufficient to keep the contents of the system in the liquid phase (approximately 300 lb. gauge) to a mixer situated between the 2nd and 3rd extractors where it joins with the propane charge stream (which has already been contacted countercur-

Dewaxed oil rerun unit, Filtrol fractionation process plant 14, unit 3, Marcus Hook



for PUMPING.....



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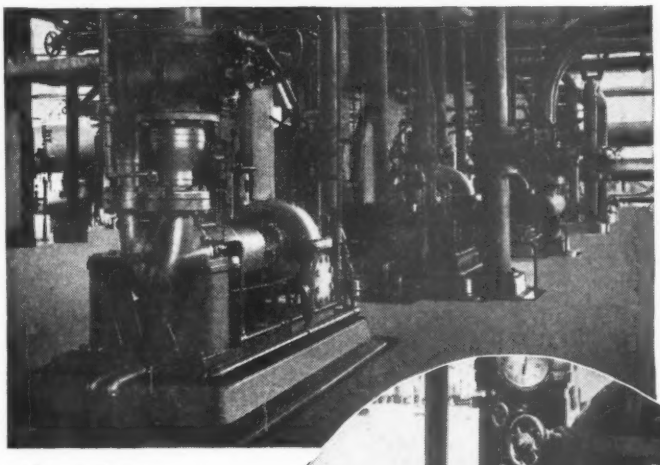
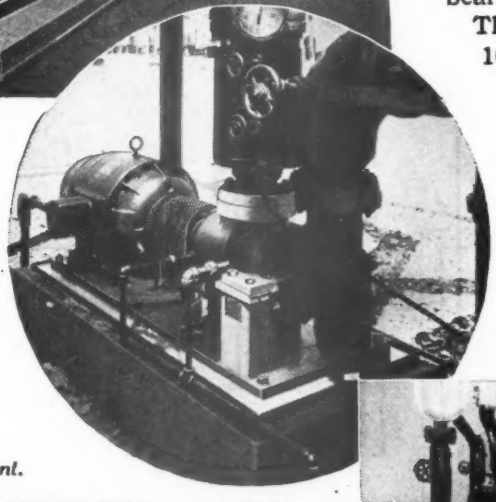


In a refinery.



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Ingersoll-Rand single-stage vertically-split process pumps are the work horses of a refinery—everywhere you go, you find them.

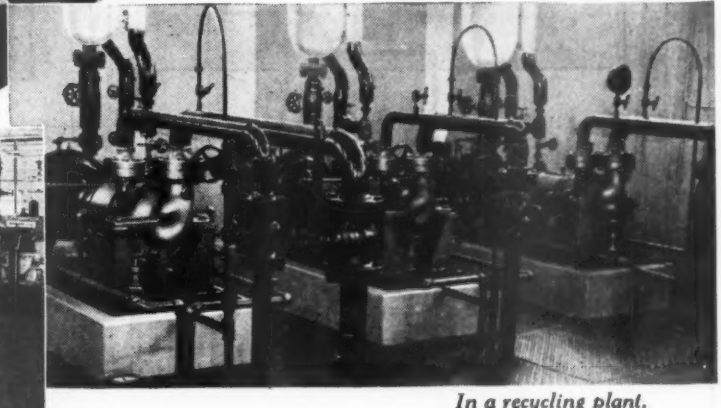
Some of the features that make them ideal for many refinery services are: (1) construction that permits complete dismantling of the pump without disturbing the pump casing, piping or driver, (2) extra-heavy casing, (3) a single casing joint, (4) a single, deep water-cooled stuffing box* and (5) a heavy bearing housing with a water-jacketed oil reservoir to provide a flow of cool oil to the bearings.

These units are available for capacities from 10 to 1000 gpm. against heads up to 600 ft, at temperatures to 800°F.

Ask the Ingersoll-Rand engineer to give you complete details on these or other pumps in our complete refinery line. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N. Y.

*These pumps may be equipped with the Cameron Shaft-Seal in place of a packed stuffing box if desired.

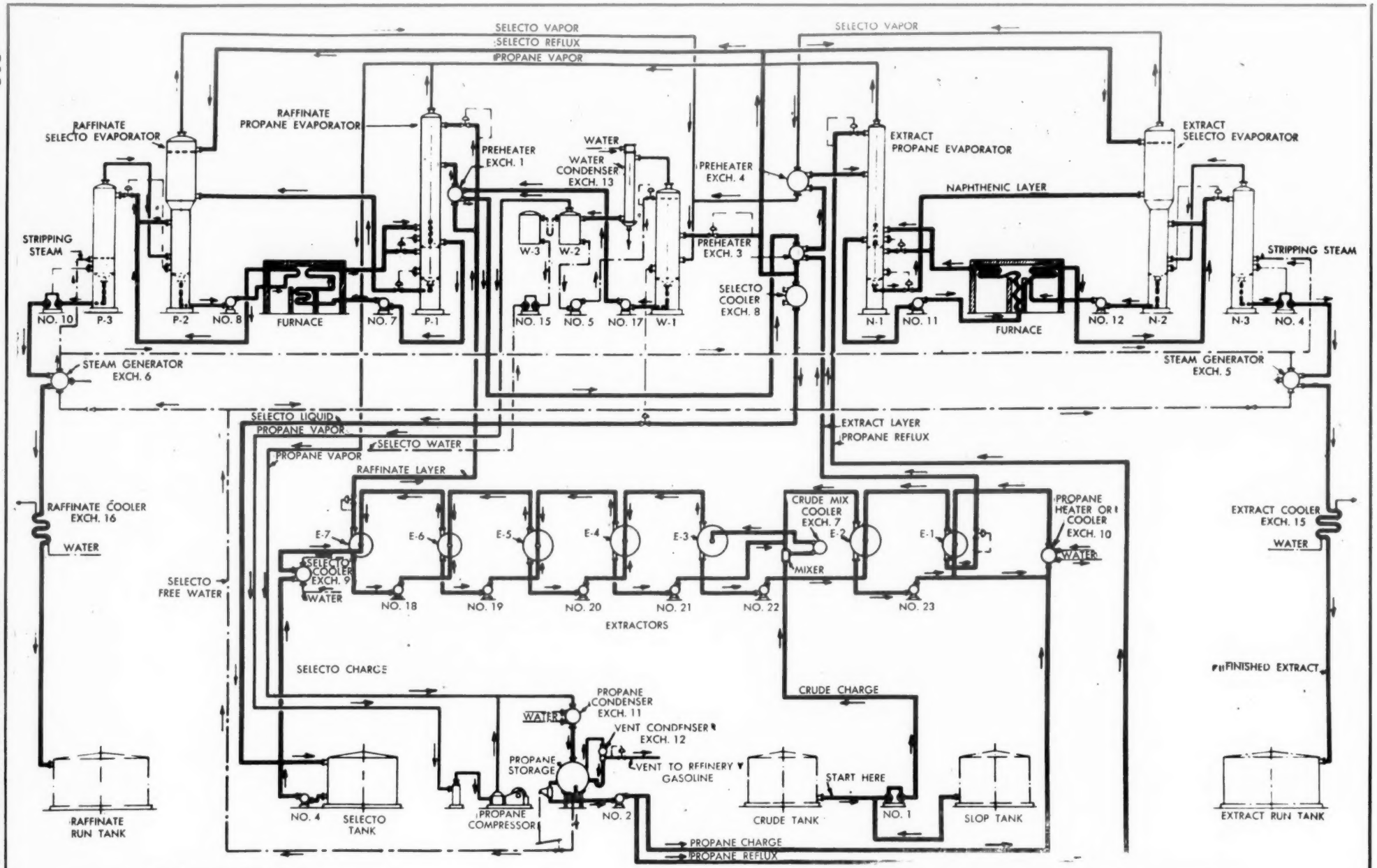
In a natural gasoline plant.



In a recycling plant.

Ingersoll-Rand

10-510

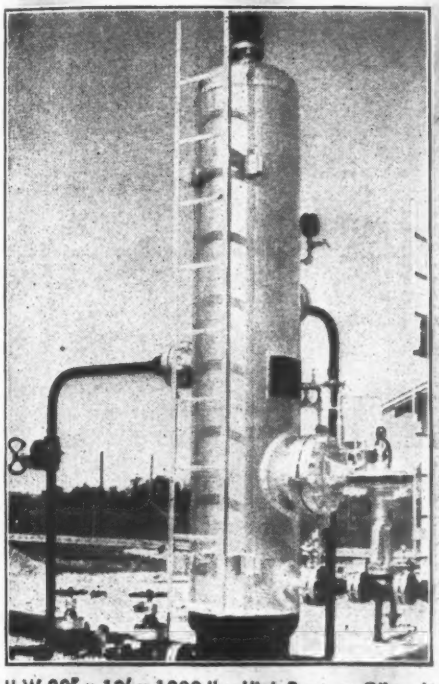


Normal process liquid lines.
Normal process vapor lines.
Process water and stripping steam.

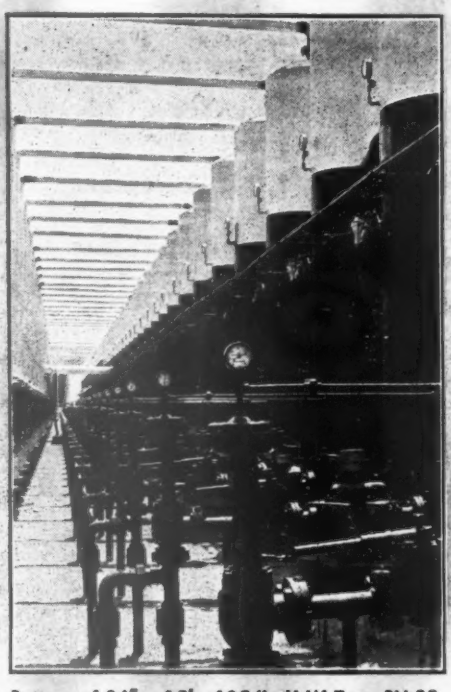
Duo-sol extraction unit, plant 14, unit 1

SEPARATORS

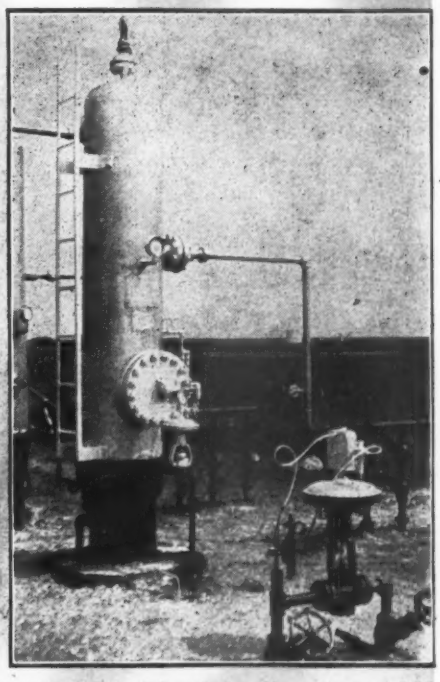
that WON'T "separate" you from profits



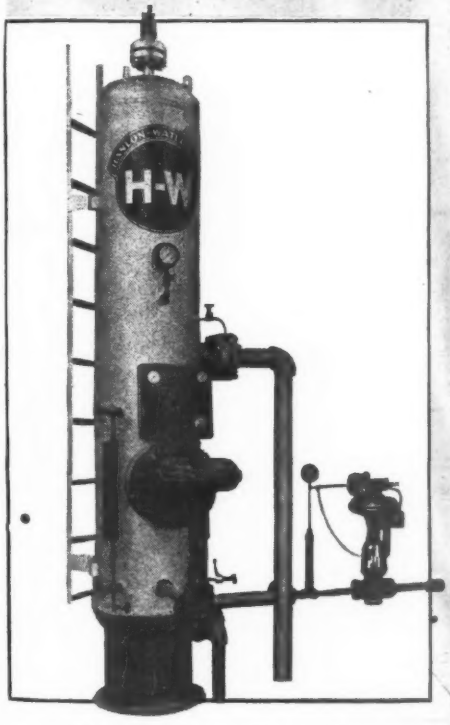
H-W 30" x 13' x 1000 lbs. High Pressure Oil and Gas Separator on lease in South Texas.



Battery of 36" x 15'—125 lb. H-W Type BV-20 special Oil and Gas Separators (with deep fluid chamber) in metering installation. Valves are pilot-operated H-W 817 Diaphragm Motor Valves.



H-W 1000 lb. Oil and Gas Separator and 125 lb. Separator in two stage hook-up—with H-W pilot-controlled high pressure, back pressure, relief regulator in foreground.



Above: 24" O.D. x 11' x 1000 lbs. W. P. H-W Type AU-10C Oil and Gas Separator, with 2" Type 86-D Motor Valve for oil outlet. Type 833 Float Flange, 8"—900 lbs., H-W Type 302 Pilot and Auxiliary Equipment Panel. Pilot-Controlled Back Pressure Regulator consisting of 2"-600 lbs. F.G.S.P. Type 86-D Type 2 Controllers, Type 303 Auxiliary Panel.

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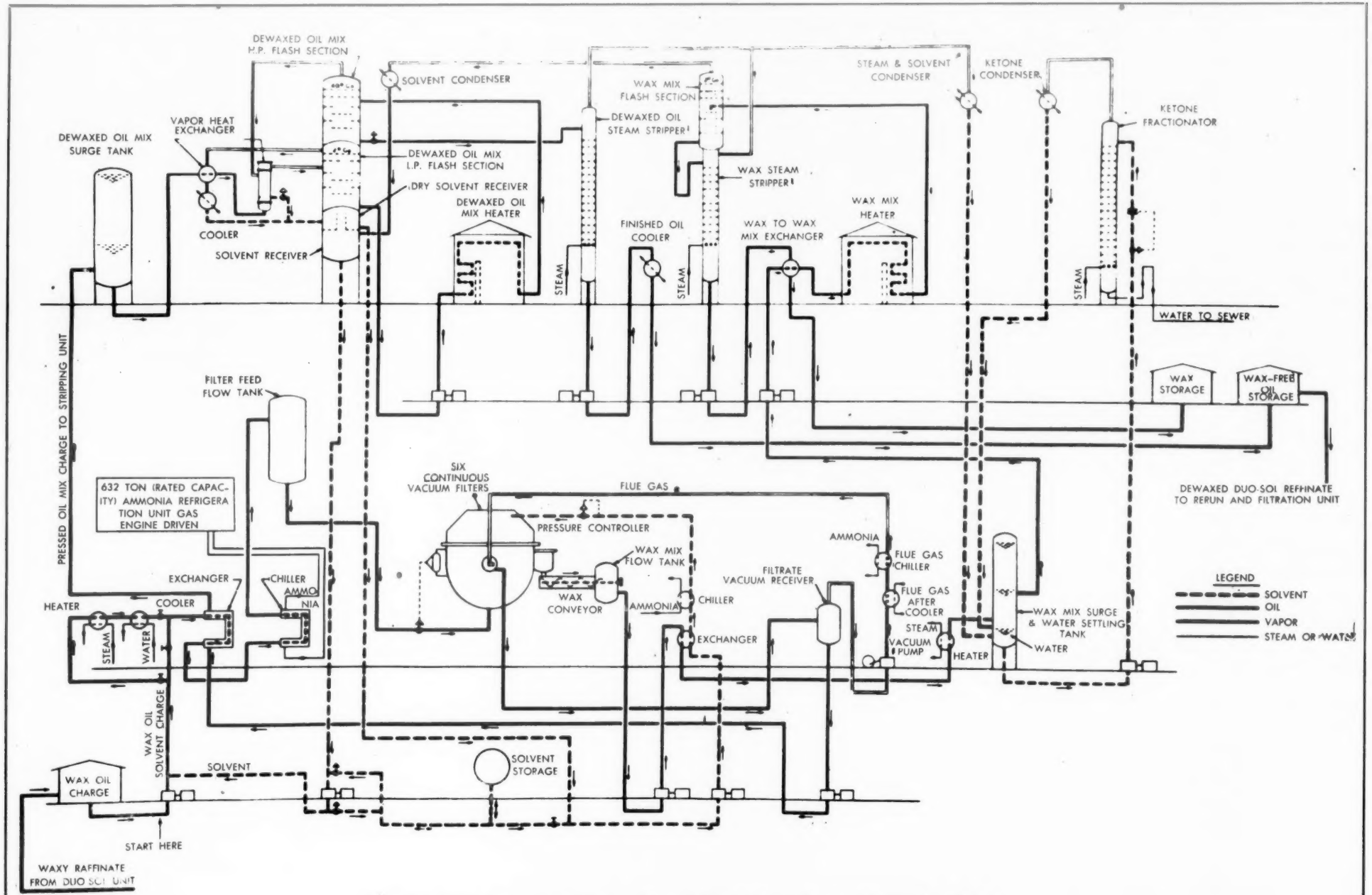

MEK-benzol dewaxing unit, plant 14, unit 2, Marcus Hook

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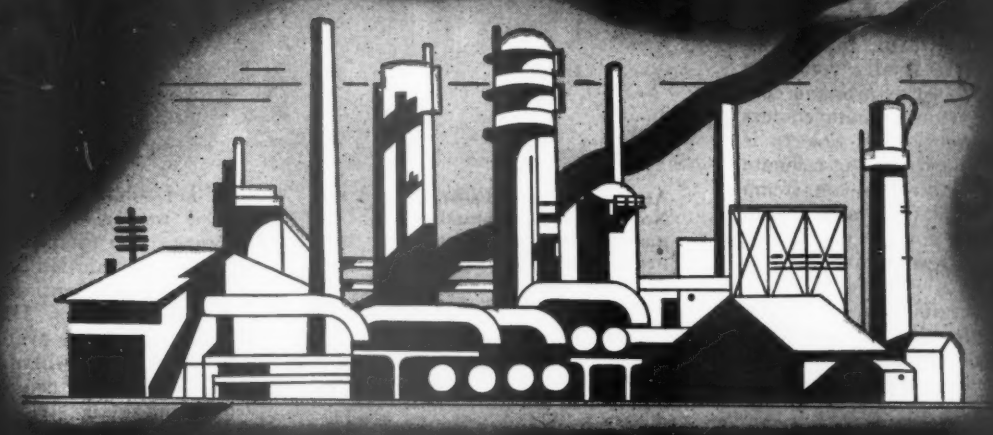

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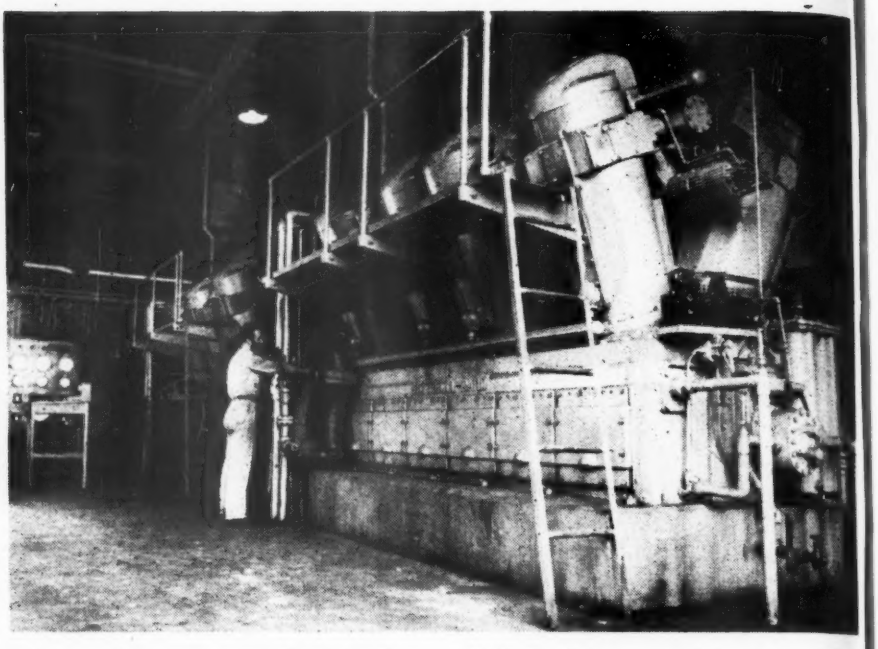
rent to the effluent extract stream in extractors 1 and 2) and with the selecto stream from extractor 4, (the selecto having been charged to extractor 7 countercurrent to the effluent propane or raffinate layer). It is thus seen that the two effluent streams come from opposite ends of the series of extractors, the extract being washed by fresh propane, the raffinate being washed by fresh selecto. The proportions of solvents to charge are from 4-6 to 1 for selecto and 2-3 to 1 for propane.

The two solvents not being completely immiscible, it is necessary to provide for the recovery of dissolved propane from the extract layer and to recover dissolved selecto from the raffinate layer. Thus, it will be seen that the recovery system consists of two complete sets of distillation and stripping towers, although products are finally combined where possible, one set of propane condensers and one set of selecto coolers serving both recovery units. Selecto is stripped out of both extract and raffinate at low pressure with direct steam, steam being condensed and the water fed to the steam generator for the production of process steam, thus minimizing the loss of solvent.

The extract containing a concentration of naphthenic oils and asphaltic materials contained in the charge is continuously cut back with a gas oil or a similar low viscosity product to obtain a bunker-C fuel oil specification. The raffinate containing a concentration of paraffinic oils and most of the waxes present in the charge is ready for further processing in the dewaxing unit.

▼ **MEK-benzol dewaxing unit.** The MEK-benzol dewaxing process utilizes the composite properties of mixtures of benzol and toluol with a ketone. Methyl-ethyl-ketone (MEK) is considered superior to acetone. By varying the proportions of the components of the solvent



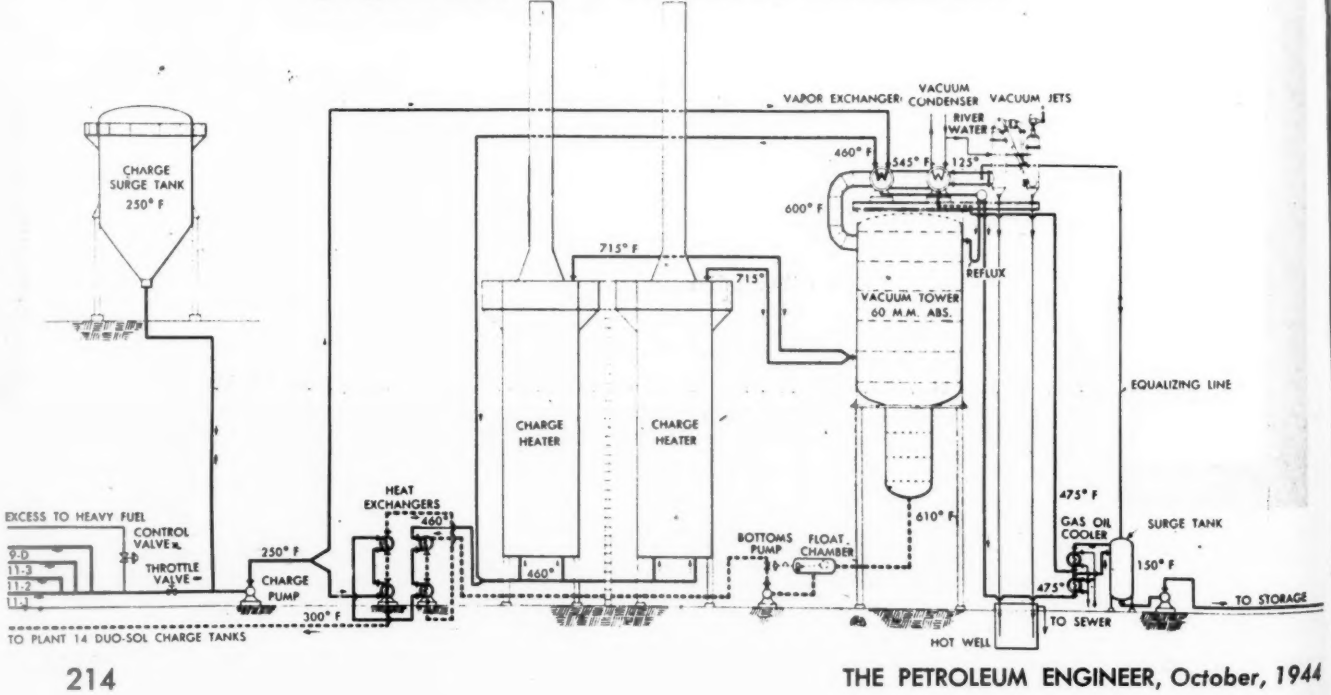
Ammonia compressor (No. 3 and No. 4) operator starting an 8LVG gas-engine-driven ammonia compressor in 14-2 unit. Center background is a 6 LVG gas-engine-driven ammonia compressor. Control board in left background.

the miscibility and the wax solubility at different dilution ratios (with respect to oil and solvent) may be controlled.

In operation, the waxy Duo-Sol raffinate is mixed in predetermined proportions (approximately 3 to 1, solvent to oil) with a solvent of the optimum composition (with respect to MEK, benzol, and toluol), the mixture being cooled first through water-cooled tubulars, next through scraped surface exchangers against the cold filtrate, and finally to the desired temperature (approximately minus 20°F.) in scraped surface chillers using ammonia as a refrigerant. The chilled solution containing the crystallized wax is fed continuously to the rotary drum filters, the wax-free oil remaining in solution in the filtrate, which flows by differential pressure to the vacuum receivers. This filtrate is then pumped through exchangers to the recovery system where the solvents are distilled off and condensed, the filtered oil being finally stripped free of solvent, cooled, and stored ready for further treatment in the rerun and Filtrol fractionation unit.

The wax contains considerable solvent and is processed in a separate recovery system where the solvent is distilled off, the traces being stripped out of the wax with steam. The water obtained from condensing the stripping steam from both recovery units is accumulated and the dissolved MEK is fractionated out of the water to prevent solvent loss. It

Vacuum distillation unit for Duo-Sol charge preparation, plant 11, unit 5, Marcus Hook



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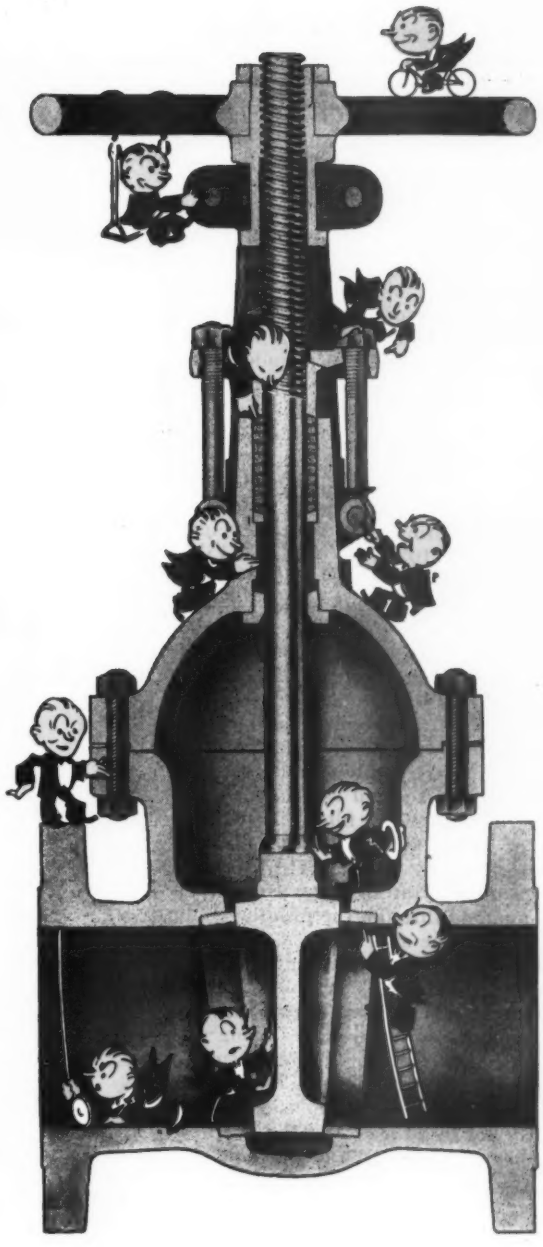

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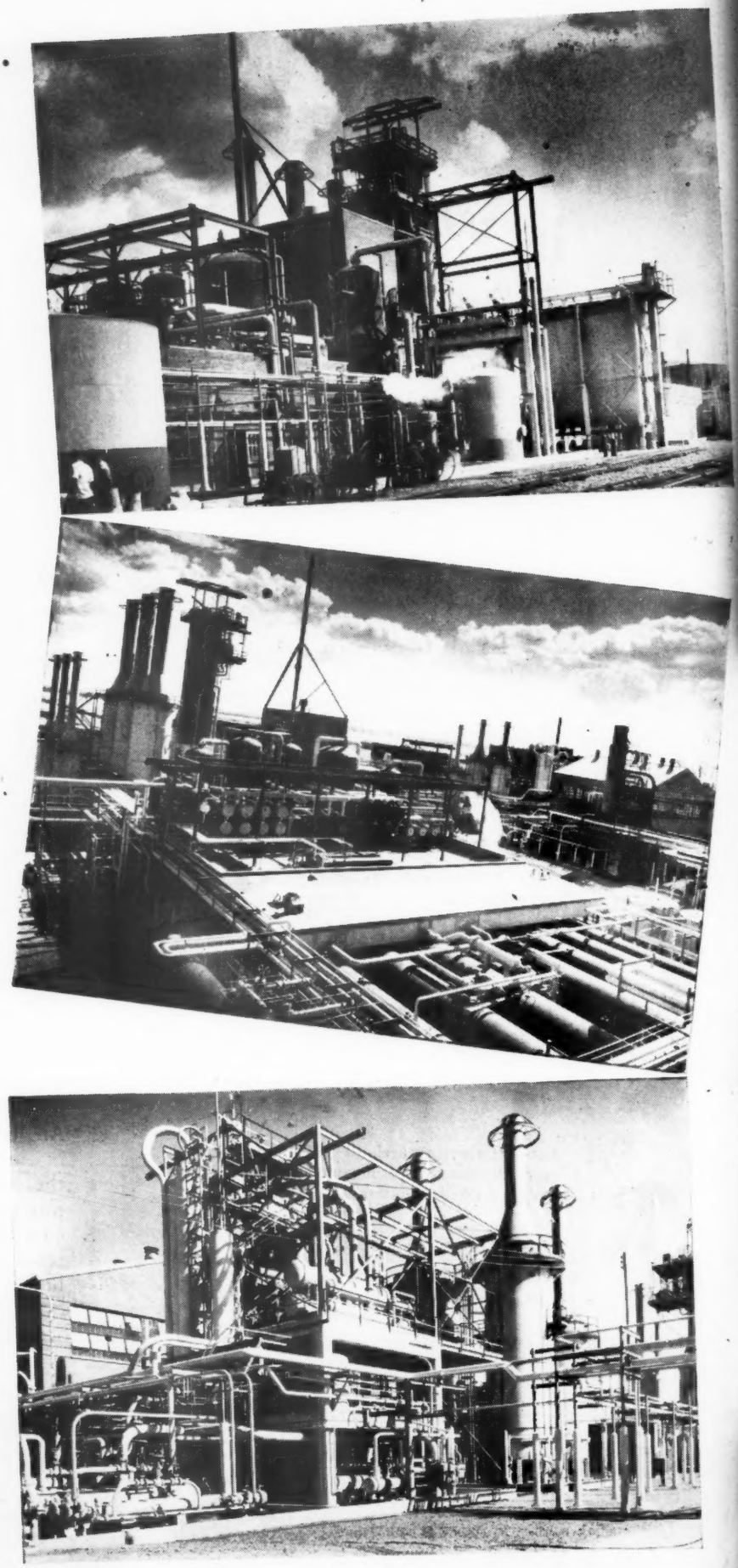
should be pointed out that the plant is arranged for a "repulping" operation upon the wax as it comes from the filters for the purpose of reducing the oil content of the wax to a minimum.

▼ **Dewaxed oil rerun unit Filtrol fractionation process.** This unit is designed to combine a contact filtration process with a vacuum tower rerun distillation. When producing aircraft oils, the function of the vacuum tower is to remove traces of light oils and decomposition products that would affect the stability and flashpoint of the finished oil. When running motor oils, it has the added function of producing side stream distillates of SAE 10, 20, and 30 specifications, and filtered bright stock bottoms. The dewaxed Duo-Sol raffinate is treated as follows: The charge is heated to about 265°F. and a portion, about 15 per cent, is mixed continuously with a weighed amount (say 10 lb. per bbl.) of Filtrol clay in a slurry mix tank, this slurry being added to the main charge stream at the inlet of the furnace coils. The charge containing Filtrol clay is raised to the proper temperature in the furnace before entering the vacuum flash tower. Bottoms from the tower containing the fine clay in suspension, is picked up by the filter charge pump from the filter surge tank and is fed continuously to a rotary drum pre-coat filter at a temperature of 300 to 400°F. The hot clay-free filtrate flows by differential pressure to the vacuum filtrate receiver from where it is pumped through the product cooler to storage. The side streams require no further treatment except cooling before running to storage. A considerable amount of superheated steam is used in the vacuum tower and passes along with uncondensed oil vapors into the vacuum condensers and finally into the vacuum jets and barometric condensers. Reflux is returned by gravity and the overhead condensed gas oil product, without further cooling, is pumped to storage.

The plant includes equipment for fresh clay unloading, storage and handling; for the disposal of spent clay, and for the special periodic pre-coating operation required to keep the filter operating efficiently. The pre-coating operation consists of periodically depositing a layer approximately 2 in. thick of Filter-



Top—Selector work tank in left foreground, 14-1 control pump house next, 14-1 solvent recovery towers, 14-3 filter building, 14-3 tower, 14-3 Super-Filtrol storage bin, and 14-3 rundown tanks. In center foreground, 14-1 W2 process water tanks.

Center—In foreground is 14-1 unit, 14-1 Petro-chem furnaces in left background, 14-3 vacuum fractionating tower just right of furnaces, 14-3 filter pump house building with vent stack on top, 14-2 unit in right background.

Bottom—Center foreground is solvent recovery tower exchangers and condensers with furnaces in immediate background, 14-2 unit. Filter building in left background and 14-3 fractionating tower in right background.

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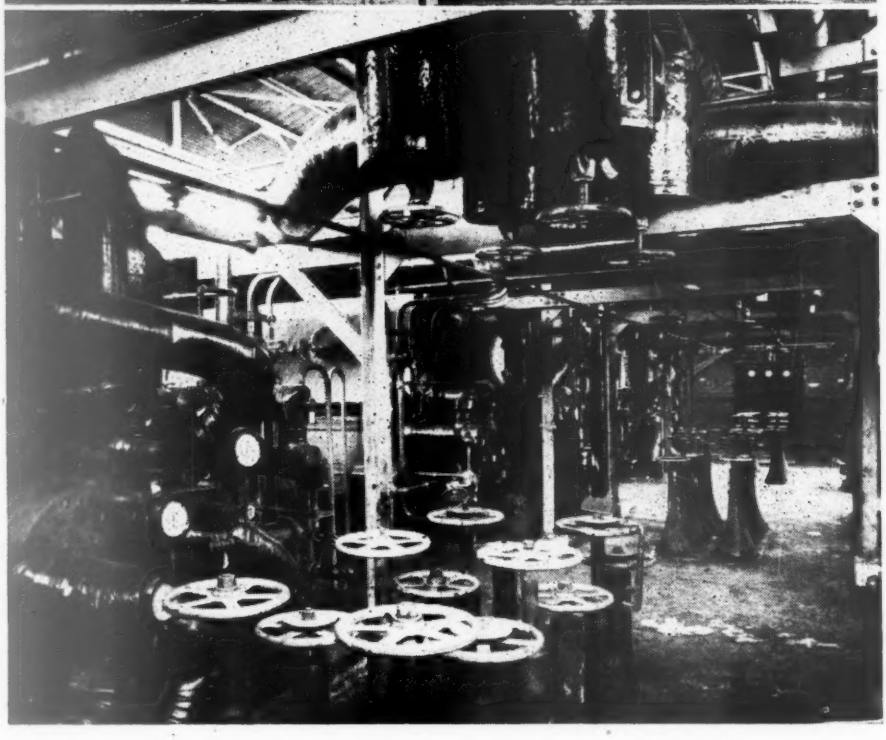

Above—Super-Filtrol storage bin in right foreground, 14-3 unit, rundown tanks to right and fractionating tower in center background. Filter building in left background. *Below*—General view of filter room, control valves, control board and filters in 14-2 unit.

cel (diatomaceous earth) upon the outer periphery of the rotary drum by producing a slurry with a light oil, heating the mixture, and operating the filter in a special circuit for building up the pre-coat cake upon the filter drum. The filtering surface thus prepared will last from a week to 10 days, the Filtrol clay being deposited on the outer surface from which it is shaved by a long carefully-adjusted knife that gradually cuts away the pre-coat layer until it is necessary to replace it as described above.

A distinctive feature of this unit is the combination of the refining action of Super-Filtrol together with a distillation of the lower viscosity lubricants. In operation the clay remains in the bottom fraction of the vacuum tower but retains high molecular weight color bodies and decomposition products that would otherwise appear to some extent with the distillates. The use of the Super-Filtrol clay at elevated temperature utilizes the highest possible efficiency of the filtration process, which as compared to conventional percolation type filtration effects a very material saving in handling, disposal of spent clay, and loss of absorbed oil.

▼ **Blending and packaging unit.** The finished oils from the preceding unit are accumulated in a relatively small number of storage tanks. The finished specification lubricants are then made up continuously from the basic refined oils and other components as may be desired by means of mechanical blending units capable of handling as many as 5 distinct streams, which merge in meter controlled proportions in an homogenizer that in turn discharges the finished oil to packages or other shipping containers. Blending units of different capacities are provided and the blending operation as a whole can handle 2 different specification finished oils simultaneously in a range from a few barrels of the blend up to a tank car or barge load without intermediate storage. ★★★

Synthetic fuel office

With the approval of Secretary of the Interior Harold L. Ickes, an office of synthetic liquid fuels has been established in the fuels and explosives branch of the U. S. Bureau of Mines, Dr. R. R. Sayers, bureau director, announces. This office will guide the 5-year program of research and development designed to provide oil and gasoline from sources other than natural petroleum.

Authorized recently by congress, the synthetic fuels program includes the construction and operation of laboratories and demonstration plants to acquire the "know how" for private commercial production of synthetic liquid fuels from coal, lignite, oil shales, and agricultural and forestry products.

The work of the office of synthetic liquid fuels will be divided among four divisions: A research and development division, a synthesis gas production division, a hydrogenation demonstration plant division, and a gas synthesis demonstration plant division. In addition, a new oil shale section has been set up within the bureau's petroleum and natural gas division.

Dr. W. C. Schroeder has been appointed acting chief of the new office of synthetic liquid fuels, which will operate under the fuels and explosives branch, headed by Dr. A. C. Fieldner, branch chief. Dr. Schroeder is a graduate of the University of Michigan and has been with the Bureau of Mines since 1935. He has served as assistant chief of the fuels and explosives branch for the last 2 years.

With an initial appropriation of $5,000,000, the synthetic fuels program calls for three demonstration plants, one for the extraction of oil from shale, another using the direct hydrogenation process of converting coal, lignite, agricultural and other products to liquid fuels, and a third utilizing the gas synthesis process for the same purpose. Research and development laboratories are planned to provide the facilities to study and improve each of these methods of synthetic fuel production.

THE PURPOSE OF AN INTERNATIONAL OIL AGREEMENT*

By **JOSEPH E. POGUE,** *Vice President, The Chase National Bank*

▼ **Introduction.** The recent Anglo-American Petroleum Agreement signed by representatives of Great Britain and the United States, with its explicit pledge that ratification will be promptly followed by an international oil conference leading to a multilateral oil compact, has aroused wide interest in world oil developments. The Interstate Oil Compact Commission is wise to make the topic of international oil agreements the subject of its consideration at this meeting.

Our government is a federal government—a federation of states. In respect to the laws governing the soil and the subsoil, and petroleum in particular, our states are sovereign. Our states, so to speak, are "nations," and the federal government is a binding and coordinating force. Most other great nations, by contrast, are unitary with sovereignty lodged in the central administration. Because of the similarity of the problems arising from a federation of states and an aggregate of nations, the experience of the United States with respect to oil can be carried over and applied in the international field.

The American petroleum industry is considering an important undertaking in the application of our interstate experience to the international field. These matters touch very closely the American petroleum industry, the state conservation bodies, and the Interstate Oil Compact Commission. Judging from experience in this country, administrative procedures for the coordination of the interests of the state and the industry do not emerge perfected from initial effort, but have to evolve by a process of adaptation.

It is as important to understand the suitability of our American oil experience for application to the international field, the needs for such extension, and the objectives to be sought, as it is to consider the nature of the initial efforts at embodiment. All proposals, of course, should receive the closest scrutiny and most careful analysis, to make sure that they merit support; and if they do not, ways should be found to alter them into acceptable form. But exclusive preoccupation with the details of articulation may raise issues that will endanger the opportunity for the furtherance of those principles that the American petroleum industry has so effectively sponsored in the United States.

This discussion does not propose to go into a legal exegesis of the proposed Anglo-American Petroleum Agreement. That analysis is the concern of legal experts and another setting. But if we agree on the fundamental needs, the ends to be served, and the means to be employed, then the right document is bound to be forthcoming under the stimulus of effective and constructive discussion.

▼ **Why an international oil agreement is desirable.** At the outset it may be asked: Is an international oil agreement desirable or necessary? And if so, why? The world has got along without one up to the present. Are there changed conditions that make the procedures of the past unworkable? Are there new problems that require solution?

The reasons are many why an international oil agreement is essential to promote the world oil economy of the future. First, oil is destined to play a pivotal role in determining the future standards of living in all nations. Second, oil has been and may again become a very important influence making for peace or discord in future international relations. Third, over the long-term, foreign oil developments may assume increasing importance to the welfare and security of the United States. Fourth, the latent oil resources of the Middle East, formerly little known and fallow, have been converted into a great potential for creating conditions of advancement or disruptions for all interests concerned, including our domestic oil producers. Fifth, the trend toward extreme nationalistic policies in many countries is holding back oil developments so important for expanding economies. And sixth, the nationals of the United States have technology and capital available for the foreign oil development that needs to be encouraged in the interest of world peace, world economic expansion, the welfare of the United States, and the prosperity of the functioning industry itself.

Writer shows need for a world oil compact based on coordination without compulsion and points out the unfortunate alternatives.

▼ **The purposes of an international oil agreement.** The long-range purpose of an international oil agreement is to facilitate the orderly and efficient development of the world's oil resources, avoiding on the one hand those repressive forces that make for an inadequate supply and preventing on the other hand the hasty exploitation of rich deposits in such manner as to cause surpluses with their train of wasteful consumption and disinvestments. Such results have been achieved in the United States as a conservation measure to prevent the waste of an irreplaceable resource and these ends have been brought about by decentralized procedures that are not repressive but permit the effective operation of competitive forces.

A more immediate purpose of an international oil agreement is to adjust the world oil industry to the impacts of the changes brought about by the war in the international situation. The great oil deposits of the Middle East have undergone more active development, new refineries have been built in many parts of the world, widespread destruction of facilities has taken place, new relationships have developed between industry and government in many countries, and we may face a difficult readjustment period in world reconstruction. Consequently for our own safety it is necessary to see that these new supplies and the changed pattern of world oil developments do not impinge upon our own economy and reverse the forward trend that has thus far characterized the developments of oil by American nationals both in our own country and in the rest of the world.

▼ **Oil must move in international trade.** Oil is irregularly developed in different parts of the world. Large oil resources are found in some areas and meager supplies are available in others. This uneven pattern is only partly the result of geological conditions, for in many countries national policies have precluded extensive search for oil. Similarly the consumption of oil varies widely from country to country. Where industrialization is advanced, consumption is large. In other countries the use of oil is small because of low standards of economic productivity. In some countries the consumption is limited by nationalistic policies that place such high tariffs on imports as to deny the benefits of oil to most of their citizens.

The unbalanced development of production and consumption in most countries means that oil must flow in international trade in large volume. The movement of course must be from countries with surplus available for export to countries with small natural supplies. These international shipments are likely to increase with expanding industrialization.

▼ **Interests concerned with an international oil agreement.** The interest of the United States in an international oil

*Presented at the fall quarterly meeting of the Interstate Oil Compact Commission, Oklahoma City, Oklahoma, October 7, 1944.

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agreement is that of promoting its national security and its own economy. These objectives involve an ample oil supply, a vigorous search for oil in all parts of the world, and a growing international trade in oil so that all countries can have the benefits brought by increasing oil consumption, with its leverage effects upon transportation and industry. Our country benefits from a peaceful and prosperous world.

Other countries have much the same interest in oil, though in lessened degree because no other country has such a high per capita consumption as our own. Countries with oil resources in excess of domestic needs are interested in world trade in oil as it affords them an opportunity to export surplus supplies and thus gain revenues and foreign exchange. Countries with large consumption but without sufficient oil resources need ample commercial supplies of oil to maintain and advance their own standards of living.

Private oil companies are interested in an international oil agreement that will reduce the political risks of operating abroad and will avoid setting up controls that may hamper the operation of proper competitive forces and thus retard development. Our domestic petroleum companies will be benefitted by orderly foreign oil operations. The American petroleum industry has displayed a special aptitude for oil discovery and the entire world would be the loser if its competence and facilities are not afforded a favorable setting for wider application. American nationals in particular are equipped with the requisite capital and technology to contribute an invaluable service to world oil expansion, but the full application of this potential requires the expectation of a return on the investment in proportion to the risks assumed. The records show that the rate of return on invested capital in foreign oil operations has averaged only slightly higher than in the United States. The reduction of political risks will open the field to a wider range of oil developments, and make operations feasible for smaller units of capital.

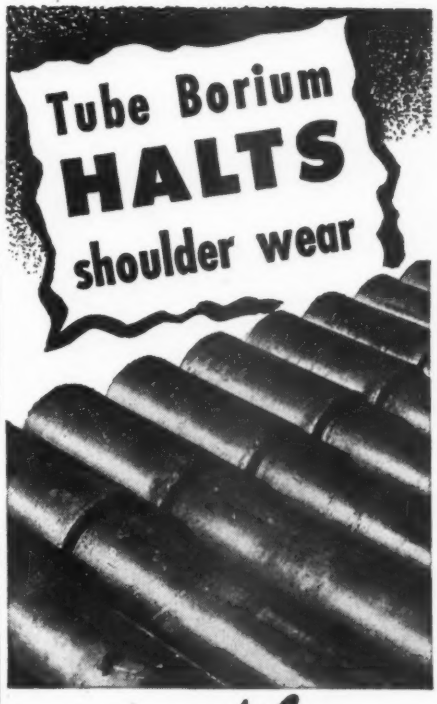
Fortunately, the interests of the United States, of other nations, and of the private oil industry have so much in common and so little in conflict that great headway can be made if these factors are coordinated through an instrumentality of collaboration and continuous consultation.

▼ **Confusion of thought as to objectives.** A criticism is frequently heard that the purpose of an international oil agreement is to create an international oil cartel, with rigid production and sales quotas, following the lines of many so-called intergovernmental commodity agreements. Some believe that an international oil agreement is designed to give a differential advantage to one or more countries at the expense of other countries. Still others look upon such an instrument as a devious means for our government to gain control of the foreign oil operations of our nationals, or even encroach upon the autonomy of the domestic industry. None of these ideas is present in the policy recommendations of the industry nor should they be admitted into any proposal that looks to the support of the American petroleum industry. They are all objectionable and should find no place in the international engagements of our country.

These objections can readily be avoided if a few simple principles, as developed in the experience of the oil industry in the United States, are clearly understood and followed. An international oil agreement should be free from implications of force or compulsion, and its administration should proceed upon a consultative and advisory level. Its findings must be of the highest technical proficiency. Its proposals should be open to voluntary acceptance by operating units, but no restrictions should be imposed upon compliance with such recommendations by our nationals. And inasmuch as governments and industry are joint parties in interest, it is essential for good results that industry be adequately represented.

The actual and potential oil resources of the world are so great that for the calculable future there exists no problem of scarcity or effective monopoly. World oil, however, may present a problem of surplus. How an international agreement can contribute to the balancing of supply and demand has been well expressed by Dr. Herbert Feis, a former economic adviser to the State Department, in these terms: "(A) hard-and-fast international agreement for the regulation of supply should be avoided. A modest and guarded approach will be well advised ... the method that recommends itself for the international coordination of production is continuous consultation, guided by agreed principles and carried into effect by the informal acceptance of those who control the main sources of supply, under the gaze of governments combined in council."

▼ **The Anglo-American Petroleum Agreement.** A comprehensive international oil agreement can best be developed in two stages. This approach was suggested in the report entitled "A Foreign Oil Policy for the United States," prepared by the Foreign Operations Committee and submitted to the Petroleum Administration for War on November 5, 1943. That report was approved in general by the Petroleum Industry War Council on December 9, 1943, and to similar effect was the resolution of the Independent Petroleum Association of America on December 11, 1943. This document gave a statement of principles that should determine the foreign oil policy of the United States, included a design for an international oil compact as an instrument for its effectuation, and specified under a section entitled "Special Cooperation with Great Britain" the following: "A large part of the known oil reserves involved in international trade are owned, controlled, or under concessions held by nationals of the United States and Great Britain. It is desirable, therefore, that the two governments take the lead in achieving an agreement on basic principles consistent with what is outlined above, to guide



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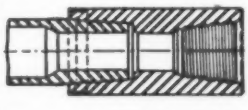

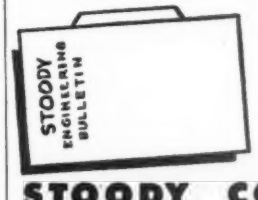

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their activities and the activities of their respective nationals during and after the war."

The Anglo-American Petroleum Agreement recently signed by the representatives of Great Britain and the United States, and now under consideration by the Committee on Foreign Relations of the United States Senate, embodies many of the suggestions made by accredited representatives of the American petroleum industry. This bilateral agreement is a proposed instrument for meeting problems arising in the interval before a broader, multilateral agreement can be negotiated as pledged in the initial understanding. One must therefore look upon the proposed agreement with Great Britain as merely a step toward a broader international agreement open to adherence by all qualifying nations, producers and consumers alike.

The text of the Anglo-American Petroleum Agreement has been available for several weeks for discussion and criticism. Some differences of opinion have arisen among those who have studied it. Some of the points are well taken; others are the result of too wide a choice of interpretations. There is much to indicate that the ideas previously expressed by industry were carefully considered in its drafting, although some suggestions were not adopted. The document is faulty in its language and should be clarified. There are ambiguities present that need to be resolved and changes that should be made. In particular, it should be clearly specified that the engagements do not invade the rights of our states, that the provisions have merely to do with holdings by American and British nationals abroad, that the findings of the proposed International Petroleum Commission shall be purely advisory, and provisions shall be made for adequate industry representation. Should these and other alterations and clarifications prove acceptable to the senate, a new document may well emerge that will merit the adherence of the American petroleum industry. My counsel to the International Oil Compact Commission is to promote enabling clarifications, so that its own great pioneering work may be available for still wider fields of application.

▼ **Conclusion.** Members of the petroleum industry have initiated the idea of an international oil agreement in full realization of its hazards if employed as an instrument of narrow state policy and of its advantages if properly implemented. The industry's basic idea of permissive coordination without compulsion must prevail if the world is to benefit fully by the potentialities of oil. The first step in an international oil agreement is logically an understanding between Great Britain and the United States, for the nationals of these two countries produce a very large proportion of the world's oil. But such an agreement should be in acceptable form and it should promptly be followed by a broader, multilateral agreement, open to adherence by all peaceful nations, if the instrumentality is to serve a fully useful purpose.

What are the alternatives to an international oil agreement? Chief among them is the possibility of serious political complications arising out of strife among the nationals of those countries chiefly interested in oil. The Middle East looms before our eyes as a potential scene of surprises, of dislocations, and of discord. Our new relations with the Soviet Union present problems for which our past experience does not guide us into solutions. Within our own country one would have to look forward to a revival of efforts by government agencies to direct and control activities that ought to be left to private initiative. In other words, unless international machinery is created for continuous consultation with reference to the problems of oil flowing in international trade, we should be faced with baffling possibilities that all of us would wish to avoid.

On the other hand with careful work on our part, with unity among our own people, and with a clarification of pending proposals, we have now a promising prospect of an early agreement with Great Britain to be followed by a broader agreement of world-wide scope. If these results can be achieved, we may look forward to an orderly development of the world's oil industry that will at once safeguard the world's peace and open the door to our own greater prosperity.

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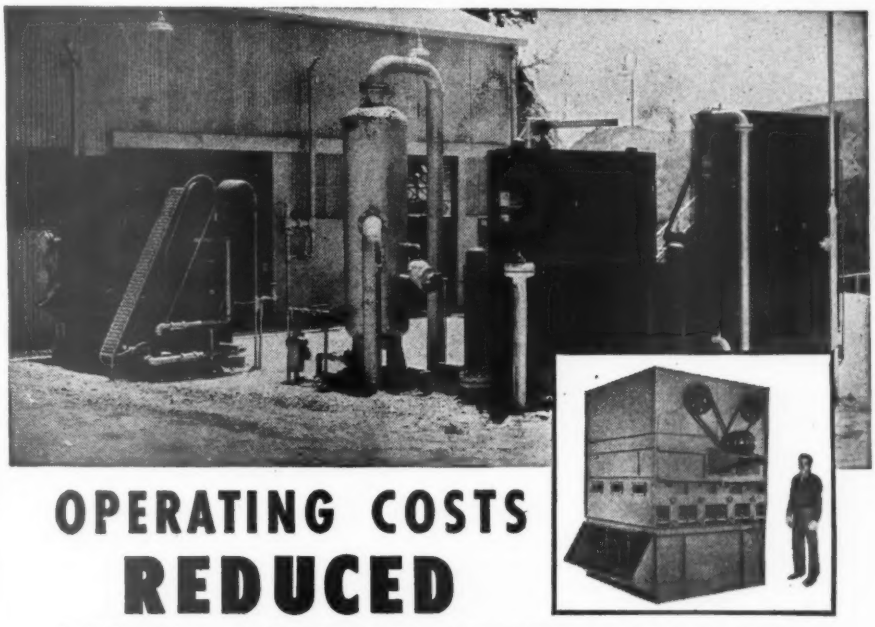

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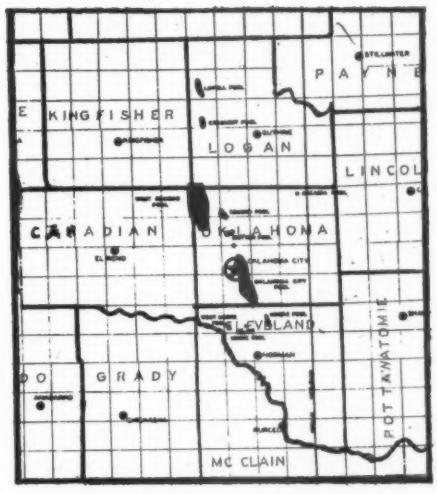
THE WEST EDMOND OIL FIELD*

By **DEAN McGEE,** Kerlyn Oil Company
Executive Vice President



LOCATION MAP
ILLUSTRATION NO. 1
Data obtained from U. S. Coast and Geodetic survey maps.

▼ **Introduction.** The West Edmond field, located in Townships 13 North, 4 West, 14 North, 4 and 5 West, and 15 North, 4 West, Oklahoma, Canadian, and Logan counties, Oklahoma, is in geographical extent and probable oil recovery the largest single oil field found in the state since the discovery of the Oklahoma City field in December, 1928. The West Edmond field may prove to be the most important oil pool found in the United States since the deep Tensleep Sand production in the Elk Basin field of Wyoming and Montana. The discovery of the field without the help of geological, geophysical or other recognized technical information, the fact that the oil and gas accumulated in a stratigraphic or wedge type trap, and the rapid development of the productive area under war time conditions are some of the interesting features of the field.

The purpose of the writer is to give a brief outline of the geological conditions existing in the area and their relationship to the accumulation of the oil in the West Edmond field, to give a relatively detailed account of the drilling, production and conservation practices and, in addition, to discuss the future development and probable size and productive capacity of the field. The field has been developed along orderly lines, and good drilling, completion, and production records have been kept. Most of this information has been available for study.

▼ **Acknowledgments.** The writer wishes to thank Harold Jenkins, George Cobb, T. W. Wheeler, and Otis Danielson, without whose help this paper could not have been written.

▼ **History.** As in Illustration 1, the West Edmond field lies from 2 to 6 miles west of the Oklahoma City, Britton, and Edmond fields. The field is in an area that has been considered on the west flank or basinward slope of the Granite Ridge line of folding, on which a number of central Oklahoma's most important oil fields are located. Over a period of years, especially following the discovery of a new pool along this Ridge, such as Oklahoma City, Edmond, Britton, or Crescent, the general area of the West Edmond field has been explored intensively by geological and geophysical methods. This work led at various times to the drilling of a few dry Wilcox sand tests.

In 1942 Ace Gutowsky of Oklahoma City acquired a block of acreage in the southwest part of Township 14 North, 4 West, the southeast part of 14 North, 5 West, and the Northwest part of 13 North, 4 West. For months he solicited the support of oil companies and individuals interested in the oil business, but, being unable to supply geological or geophysical data that made the area appear attractive, he could not sell sufficient acreage on his prospect to finance the drilling of a well. He then enlisted the aid of B. D. Bourland of San Antonio, and together they interested the Fox brothers and Herbert Schmitz of Chicago in the venture. A contract was signed for the drilling of the well to 7350 ft., at which depth Gutowsky expected to encounter the Wilcox sand. The location was made for the Wagner No. 1 in the NW NW SW of Section 32, Township 14 North, Range 4 West, Oklahoma County, and actual drilling commenced on January 2, 1943. After the drilling was started several companies purchased

Fast growing field in Central Oklahoma has history of contradictions but accurate operational data for modern development.

acreage from Gutowsky and Bourland, and the well was carried deeper when the Wilcox was not found at 7350 ft. The Wagner reached a total depth of 7690 ft. in the Wilcox sand on March 25, 1943. In the course of the drilling a show of oil had been found in the Hunton limestone. Seven inch O.D. casing was set at 7301 ft. through the Hunton lime, which was found at 6866 ft. A cable tool unit was moved on the location on March 31, 1943; the well bailed dry and perforated on April 5, 1943. Eleven holes were shot in the casing from 6951 to 6956, and the well started to head through the open casing. On April 28, after additional perforating and after 2½-in. tubing had been run, the well flowed 522 bbl. of oil in 24 hr. through a 9/32-in. choke. The oil was light and of 41° Bé. gravity, corrected to 60° temperature. The original bottom hole pressure taken on May 3, 1943, showed a corrected value at minus 5864 datum of 3110 lb. per sq. in. The State Conservation Department gave the well an allowable of 300 bbl. per day plus a discovery allowable of 94 bbl. per day for a period of one year over and above the regular allowable for other wells in the pool.

Gutowsky gives credit for the discovery of the West Edmond field to the "doodle-bug." During the long period of time when he was attempting to interest the oil business in Oklahoma in putting some money into the venture he had a number of Oklahoma's best known "doodle-bugs" survey the location. It is rumored that some failed to find evidence of oil accumulation but that the majority agreed upon the fact that large production would be found when the well was drilled.

The Wagner No. 1 has been on production since its discovery, and as of September 1, 1944, had produced an estimated 167,410 bbl. of oil. The bottom hole pressure has dropped during this period a total of 465 lb. Only an estimate of production is possible, since there are 4 wells on the lease flowing into the same tank battery, and consequently production from the Wagner No. 1 has not for some time been measured separately. It is interesting as a matter of idle speculation that, based on a drop of 465 lb. bottom hole pressure, with a production of 167,410 bbl., the total recovery from this well would be 1,450,000 bbl. if the same rate of recovery per pound drop in pressure held throughout its production history.

▼ **Surface formations.** The Hennessey shale of the Enid group of lower Permian age outcrops over the entire area of the West Edmond field, with the exception of the valley of Deer Creek, which runs from southwest to northeast across Township 14 North, Range 4 West. The Hennessey shale forms unwooded, flat to gently rolling pasture lands.

▼ **Subsurface formations.** The names used for identifying the subsurface formations in the West Edmond field are those that have come into common usage in the nearby Oklahoma City, Britton, and Edmond fields. The actual correlation with type localities in many cases has not been satisfactorily made, and no attempt is made here to do other than to identify them by their commonly known field names, as in Illustration 2. Wells in the West Edmond field penetrate on an

*Presented at the fall quarterly meeting of the Interstate Oil Compact Commission, Oklahoma City, Oklahoma, October 6, 1944.

average 6900 ft. of rocks above the Hunton limestone. Of this 6900 ft. of sediments, approximately 2200 ft. are of lower Permian age and 4600 ft. of Pennsylvanian age. The remaining 100 ft. are of Mississippian age the subsurface horizons are easily identified. There are a number of key beds that are persistent over the whole area. They are very regular in their occurrence. The stratigraphy of the field has been well known from the time of the discovery, since it is similar in all respects to the stratigraphy of nearby fields where the geological section has previously been worked out in complete detail. Samples of drill cuttings have been carefully saved, and with one or two exceptions electrical logs have been run on all wells drilled in the field. Consequently, stratigraphy has not been a problem in the development of the West Edmond field.

▼ **Permian.** The Permian section consists of red shales and sands at the top and red and brown shales with streaks of sand in the middle portion. These grade into gray shales with thin streaks of limestone in the basal part of the section.

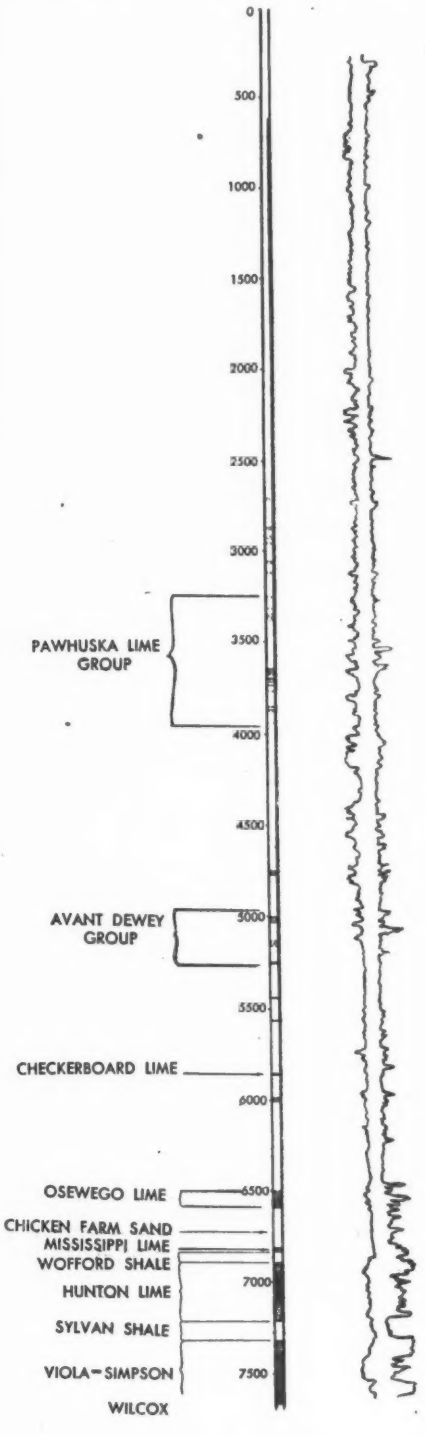
▼ **Pennsylvanian.** The Pennsylvanian section consists largely of gray shales with a few persistent limestone horizons and about 3 to 4 thick sand bodies. The commonly identified marker beds are the "Pawhuska" limestone series at about 3300 to 3800 ft., the "Tonkawa" limestone series at about 4800 ft., the "Avant-Dewey" at about 5000 to 5200 ft., the "Checkerboard" limestone at about 5850 ft., and the "Oswego" limestone at about 6500 ft. The well developed sand bodies are around 4100 ft., 4500 ft., and 4800 ft. There is a long shale interval above the Checkerboard, which carries only a few thin streaks of sand and lime from about 5300 to 5800 ft., and another shorter shale interval from about 6100 to 6500 ft. A shale section below the Oswego limestone has locally developed in it the "Chicken Farm" or "Bartlesville" sand, which usually occurs about 225 ft. below the top of the Oswego or about 80 ft. above the base of the Pennsylvanian. This sand zone varies from a sandy shale to a fairly clean shaly sand, and ranges in thickness from zero to 30 ft. East of the field, on the Granite Ridge line of folding, the Chicken Farm sand moves down in the section and in places occurs only 30 ft. above the base of the Pennsylvanian.

▼ **Pre-Pennsylvanian.** Unlike the nearby Edmond, Britton, and Oklahoma City fields, post-Mississippian erosion and truncation did not remove entirely the Mississippian beds from the area of the West Edmond field. A relatively thin section of Mississippian rocks is present in the discovery well. However, these beds thicken on the west edge and in the north portion of the field. The Mississippian section should show thickening as the field is extended farther north in Township 15 North, 4 West. This thickening of the Mississippian beds largely occurs in the topmost member, the Mississippi limestone.

▼ **Mississippi limestone.** The Mississippi limestone is a gray, granular to finely crystalline limestone. The thickest section drilled to date is 118 ft.

▼ **Chattanooga shale.** The Chattanooga shale under the Mississippi limestone is the usual dark brown bituminous shale. It varies in thickness from 40 to 60 ft.

▼ **Hunton limestone.** The Hunton limestone, principal producing zone in the West Edmond field, is composed of 3 members: The Bois d'Arc member at the top, the Haragan-Henryhouse in the middle, and the Chimney Hill member at the bottom. The total Hunton section varies in thickness over the field, due principally to a variation in thickness of the top or Bois d'Arc member. In the discovery well the Hunton limestone was 330 ft. thick, the Bois d'Arc was 90 ft., the Haragan-Henryhouse 110 ft., and the Chimney Hill 130 ft. thick. At the south end of the field the Bois d'Arc is thickest (130 ft.) and, consequently, the whole Hunton section is thickest. In the middle part of the field the Bois d'Arc thins to approximately 60 ft. and at the present northern limits of production in the southwest part of Township 15 North, 4 West, the Bois d'Arc has a thickness of approximately 30 ft.



COLUMNAR SECTION
WEST EDMOND POOL
ILLUSTRATION NO. 2

Early drilling in the field rather definitely proved that the production in the Hunton lime was limited to the Bois d'Arc member and, consequently, only a few wells have drilled the entire Hunton section, so that there is not too much information available on the variation in the thickness of the lower two members of the Hunton lime over the entire area of the field. However, the few field wells that have been drilled through, and outpost wells that had been drilled around the field prior to its discovery, indicate a rather uniform thickness in the two lower members. The thinning in the Bois d'Arc member at the top of the Hunton is due to pre-Mississippian erosion and truncation and not to deposition.

The Bois d'Arc member, where it is present in maximum thickness, consists of approximately 60 to 65 ft. of coarsely crystalline lime at the top, 40 to 50 ft. of finely crystalline dolomite, with streaks of lime, in the middle portion, and 20 to 30 ft. of oolitic lime, which is dolomitic at the base.

The Haragan-Henryhouse, the middle member of the Hunton, is a gray to tan finely crystalline dolomite.

The Chimney Hill member, the basal member of the Hunton, is a medium to coarsely crystalline limestone with an occasional streak of dolomite.

▼ **Sylvan shale.** The Sylvan shale, which underlies the Hunton limestone, has a thickness of approximately 100 ft. It is a pale green to gray splintery shale.

▼ **Viola-Simpson section.** In the discovery well there is an interval of 335 ft. from the top of the Viola limestone to the top of the Second Wilcox sand. Of this interval 75 ft. is Viola limestone and the remainder Simpson dolomite with streaks of lime, with the exception of a sandy 10-ft. zone 225 ft. below the top of the Viola limestone, which represents the First Wilcox sand.

The 75 ft. of Viola limestone is divided into an upper 55 ft. of coarsely crystalline gray to white limestone, and a lower 20 ft. of dense to lithographic limestone.

The Simpson dolomite section is composed largely of tan to gray finely crystalline dolomite. The Second Wilcox sand is composed of the usual frosted, rounded, well-assorted grains. This sand was penetrated 30 ft. in the discovery well.

▼ **Structure.** The oil and gas in the West Edmond field accumulated as a result of the wedging out to the east of the producing zone and a rather gentle north-

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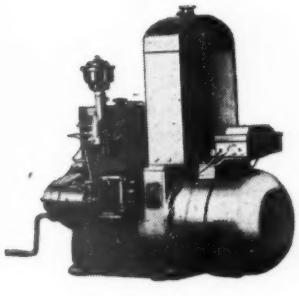

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south arching of the pre-Pennsylvanian beds, the combination of which produced a very complete and effective trap. The wedge out of the producing zone is shown on Illustration 3.

Since, except for the gentle north-south arching, the existing structural picture can be described as a monocline dipping to the west at the rate of about 150 ft. to the mile, a study and discussion of the structure of the area must, to be pertinent, not only be directed at determining the structural movements but the subsequent periods of erosion and truncation that produced the conditions found in the West Edmond field.

As in Illustration 1, the field lies immediately west of the Granite or Nemaha Ridge line of structures. This series of producing structures is the dividing line between the broad structural plateau of central Oklahoma and the extremely deep basin of western Oklahoma. The field lies well up on the west slope of the Granite Ridge, and its origin is definitely linked to the history of the most pronounced of all producing Granite Ridge structures, the Oklahoma City Uplift. The Britton and Edmond structures here are considered to be a part of the Oklahoma City Uplift.

The Oklahoma City area began to rise in Ordovician time and continued to be pushed up gently until late Mississippian or early Pennsylvanian time, during which period the upward movement became very pronounced. The uplifting affected an area approximately 25 miles east and west and 40 miles north and south. A major part of the West Edmond field lies within the affected area.

Illustration 4 shows distribution of beds below rocks of Mississippian age. This map shows that the Oklahoma City structure has been peneplained until rocks of Arbuckle limestone age were exposed at the crest of the anticline and until beds of Wilcox sand age were exposed at the top of the smaller Edmond fold. Younger rocks are exposed in concentric bands around this central core of older beds. The Hunton limestone, the youngest group of rocks exposed on the pre-Mississippian surface and the horizon with which we are concerned in the West Edmond field, has been divided on the map into two parts—the productive Upper Bois d'Arc member and the lower members. The map shows clearly the westward dipping band of Hunton rocks around the west side of the Oklahoma City Uplift and along the west slope of the Granite Ridge fold north of the Oklahoma City area. While the lower part of the Hunton section carries over the north end of the Oklahoma City fold, the Bois d'Arc member wedges out along the west slope. On this map are shown contours on the base of the Bois d'Arc member of the Hunton limestone. The contour interval of 250 ft. shows the basinward dip of the beds on the west flank of the Granite Ridge line of structures. In addition the arching that gives the Hunton limestone its structural closure at the north and at the south ends of the West Edmond field is shown. In the south part of the field, the westward dip steepens and the strike of the contours swings to the southeast.

Illustration 5 is a pre-Pennsylvanian map of the area in and around the West Edmond and Oklahoma City fields, showing the distribution of rocks with the Pennsylvanian beds stripped off. The interesting thing about this map is that it shows the very large area affected by the Oklahoma City Uplift, and the fact that by the end of Mississippian time the area of the West Edmond field was relatively low structurally as compared to the Oklahoma City structure. It was probably during this period of late Mississippian or pre-Pennsylvanian uplifting that the arching occurred in the area of the West Edmond field. The tilting to the south in the West Edmond field undoubtedly came at the same time as the tilting in the Oklahoma City Uplift, which is probably of late Pennsylvanian age.

Immediately east and on the downthrow side of the fault, which bounds the Oklahoma City structure on the east, a full section of Hunton limestone is present. The pre-Pennsylvanian truncation of the Oklahoma City Uplift, which cut so deeply into pre-Pennsylvanian beds and which removed the Hunton limestone from a large area around the Oklahoma City Uplift, makes impossible an accurate determination of the distribution of the Hunton limestone in pre-Mississippian times. However, the evidence available indicates that in the hiatus between Devonian and Mississippian times the north end of the West Edmond field was

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probably higher structurally, and, consequently, probably underwent more erosion and truncation than the area farther south, around and over the present Oklahoma City Uplift. This is evidenced by the relatively thin section of Hunton at the north end of the West Edmond field, as compared to a full section in the south end of the field, and a complete section immediately east of the Oklahoma City Uplift. The distribution of the pre-Mississippian rocks shown on the map is, of course, affected by the truncation that occurred at the end of Mississippian time, and is not intended to represent a reconstructed surface as it existed at the end of Hunton time. Rather it is a combination of the effect produced by both periods of erosion and peneplanation.

Illustration 6 is a structural map of the field contoured on the base of the Bois d'Arc member of the Hunton limestone. The contour interval is 50 ft. The most interesting feature on the map is the fault that crosses the field from east to west in the south part of Township 14 North, Range 4 West. This fault has approximately 100 ft. of throw, and the upthrow side is on the north. The fault has had little or no effect on the accumulation of oil in the Bois d'Arc zone.

Illustration 7 shows the thickness of the Bois d'Arc member of the Hunton limestone. The thickness is shown in intervals of 25 ft. This map shows graphically the wedge-out of the Bois d'Arc member along the east edge of the field and its increase in thickness down dip toward the west and southwest edges of the field. Also shown is the thinning of the member to the north. An interesting feature is the erosional valley, which wanders across the producing area in the south part of Township 14 North, Range 4 West. This valley is undoubtedly the channel of an old stream, which probably flowed west across the Bois d'Arc limestone surface. The channel cut completely through the Bois d'Arc member in Township 14 North, Range 4 West, and in places cut well down into the underlying Haragan-Henryhouse member. The Bois d'Arc member is probably present in the stream channel, as shown on the map, at the west edge of the field, but at this point the top of the Bois d'Arc is below the water level of the field. Consequently, the stream channel acts as a definite barrier between the north and south portions of the field. There is probably not now any appreciable communication between the oil bearing area in the north and that in the south portion of the field.

▼ **Oil and gas horizons.** The first oil produced in the West Edmond field was from the Bois d'Arc member of the Hunton limestone. Subsequent drilling in the field has developed production in one other member of the Hunton limestone and in a sand near the base of the Pennsylvanian section in the "Cherokee" shale. One hundred and sixty-four producing wells had been completed in the field on September 26. Of this number 3 are producing from the Pennsylvania sand, known locally as the "Chicken Farm" or "Bartlesville," and 2 are producing from the Chimney Hill member of the Hunton limestone.

A production gauge on the discovery well from the Bois d'Arc member, taken April 28, 1943, showed 522 bbl. in 24 hr. through 9/32-in. choke. The average initial production of the wells since completed in the Bois d'Arc is approximately 1200 bbl. per day. This initial production is after treatment with an average of 1000 gal. of acid. Initial production of individual wells ranges from a minimum of 25 bbl. per day to a maximum of approximately 4800 bbl. a day. The production from the Pennsylvanian Chicken Farm sand is relatively unimportant, the 3 wells ranging, after being shot with nitroglycerine, from 30 bbl. per day to 128 bbl. per day. The 2 wells producing from the Chimney Hill member of the Hunton limestone are small, producing an average of 50 bbl. per day. The locations of these 3 Chicken Farm sand wells and the 2 Chimney Hill wells are shown on the map.

All the wells producing from the Bois d'Arc member of the Hunton limestone are flowing naturally with the exception of 2 wells that are on the pump. These 2 wells are on the west edge of the field in the water producing area. The discovery well had a gas-oil ratio of 1250 cu. ft. of gas per barrel of oil. The average of 16 completions since August 1, 1944, shows a variation in gas-oil ratio from 515 to 1400 cu. ft. per barrel, with an

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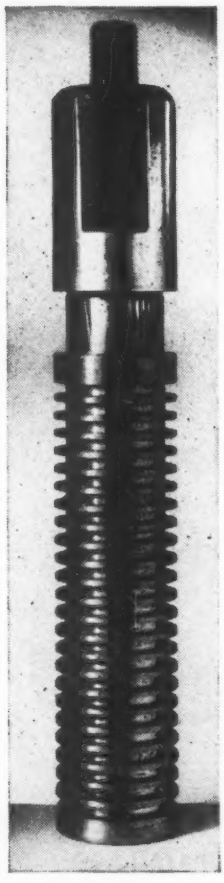

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average of 935 cu. ft. This group of wells is representative of the field as a whole, with the exception of the wells in the low pressure area immediately north of the fault and south of the erosional valley in Sections 28 and 29, Township 14 North, Range 4 West.

The Bois d'Arc member in the south portion of the field consists of from 50 to 65 ft. of coarsely crystalline limestone at the top, with from 50 to 60 ft. of finely crystalline to vugular dolomite with streaks of lime in the middle, and 15 to 25 ft. of highly oolitic lime at the bottom, with a lime to dolomite matrix. Porosity is developed locally all through the section. The unusual feature of the porosity developed is the fact that it appears to have been produced by means other than weathering at the unconformity surface and some of the porous streaks appear to be void space between crystals and in fractures. In other zones small solution cavities give the zone a vugular texture. In the north portion of the field, especially in the northernmost producing well in Section 29, Township 15 North, Range 4 West, the Bois d'Arc member has thinned by truncation to approximately 30 ft. in thickness. Only the lowest part of the Bois d'Arc member is present, but this zone has developed porosity.

The total thickness of effective porosity in the Bois d'Arc member in any particular area of the field is impossible to determine on the basis of the information now available. A few wells in the field have attempted to core the entire pay section. On the whole the core recoveries have been poor. Even in the few cases where there has been good recovery, only the denser portions of the lime section appear to have been recovered. Electric logging reflects the Bois d'Arc thickness fairly accurately but fails to show local variations in porosity within the formation itself. Permeability analyses are not available.

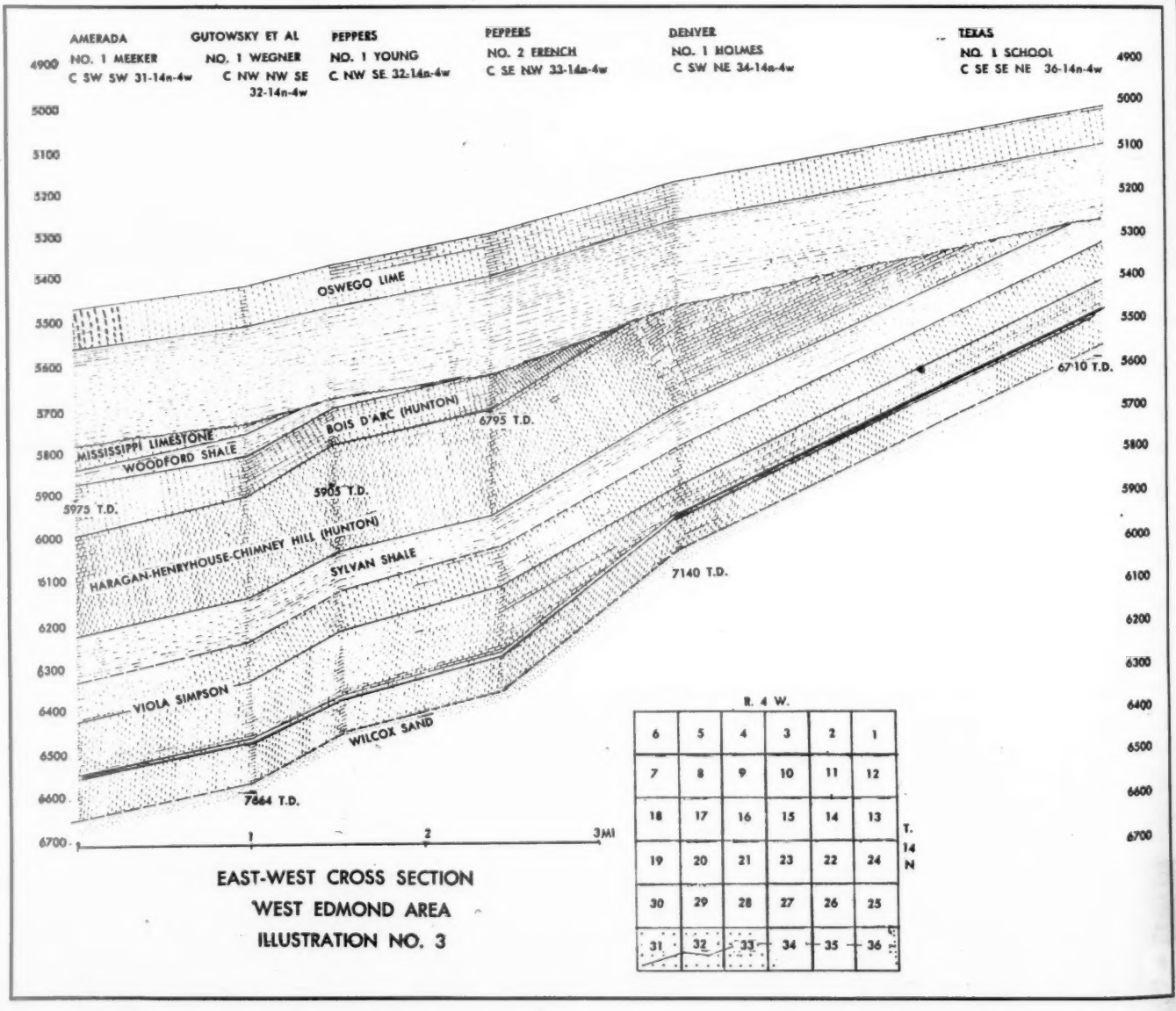
The Pennsylvanian sand, known as the "Chicken Farm," is widespread in its occurrence around the Oklahoma City Uplift, but develops good sand characteristics over only small areas. Generally it is a very shaly sand to a sandy shale. In the West Edmond field its occurrence is very erratic, most wells showing only a sandy shale zone at this horizon. Undoubtedly other wells, in addition to those now producing, will find production in this zone where clean sand has been deposited locally.

The Chimney Hill member of the Hunton limestone is not expected to be an important producing horizon in the field. Porosity is not well developed in this member and, as noted previously, the 2 wells that are now producing from it are small in size.

There are no recorded shows of oil and gas in any of the horizons above the Chicken Farm sand in the Pennsylvanian or Permian sections. This is to be expected, since production from these zones is usually associated with closed anticlinal structures.

Subsurface data developed by the drilling to date does not indicate folding in the pre-Pennsylvanian beds of sufficient magnitude, anywhere within the producing area of the West Edmond field, to give rise to the hope that a fold will be developed that will make possible production from the Wilcox sand.

▼ **Production practices.** In the discovery well, the Wagner No. 1, the operators set 7-in. pipe through the producing zone, bailed the hole dry and perforated in a dry hole and permitted the well to come in flowing through the casing. Subsequently 2½-in. tubing was run while the well was flowing. The first few wells completed in the field after the discovery



EAST-WEST CROSS SECTION
WEST EDMOND AREA
ILLUSTRATION NO. 3

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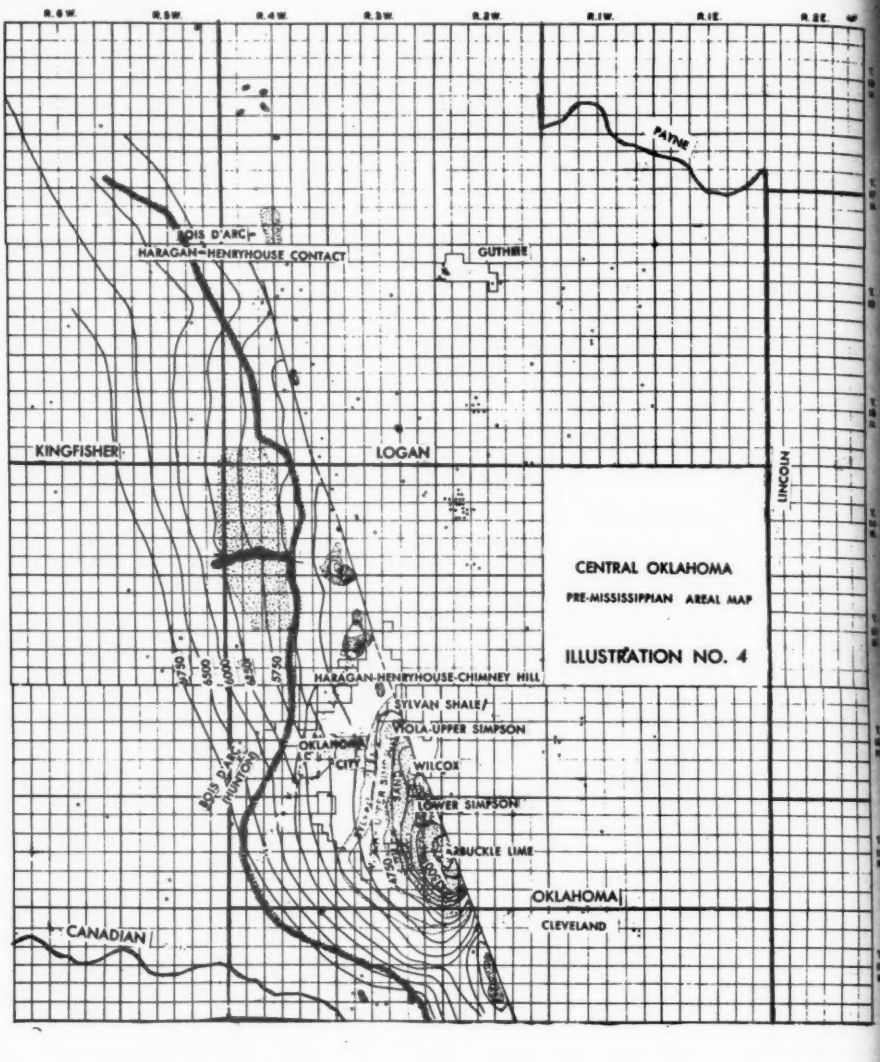
were handled in much the same manner. This practice was soon discontinued because of the hazards in running tubing either under pressure or while the well was flowing and also because of concern over the possibility of coning water into the producing formation while the well was flowing wide open through the casing. It has become the practice to set the pipe completely through the Bois d'Arc member, perforate the pay zone with the hole loaded with mud, then run the tubing, displace the mud with water and then either swab in the tubing or wash the well in with oil. Most wells respond to washing, and the practice of swabbing has largely been discontinued. With most operators it is the practice to let the well flow for a short period in order to clean up the formation as much as possible, then acidize with 1000 gal. of 15 per cent acid as a wash treatment. Some operators wash with acid after perforating and before unloading the hole. The crystalline limestone in the Bois d'Arc member is soluble and responds very readily to acid treatment. The 1000-gal. treatment has in most cases been sufficient to start the well flowing at a reasonably high rate of production. The entire Bois d'Arc section is usually perforated with some 3 to 4 holes per foot, which makes an average perforating job consist of about 200 holes with a minimum of about 90 and a maximum of about 400.

A few operators have followed the practice of setting casing on top of the Bois d'Arc section. Sometimes the entire section is drilled before the casing is set and sometimes the casing is set and then the section drilled. The wells completed in this way do not appear to show substantial increases in production over those completed by perforating.

Both 7-in. O.D. and 5½-in. O.D. production strings of casing are used in the field. The usual casing program specifies from 300 to 600 ft. of surface pipe, which may either be 10¾ in. O.D. or 9⅝ in. O.D. casing, depending on whether 7-in. or 5½-in. production string is to be set; then 7-in. O.D. or 5½-in. O.D. casing, either through the Bois d'Arc section or on top of it. No intermediate casing strings are used. The production string of casing averages about 7100 ft. in length. Thirty recent completions in the field show the following casing programs: 27 wells, 10¾-in. surface pipe; 3 wells, 9⅝-in. surface pipe. These 30 strings varied in length from a minimum of 300 ft. to a maximum of 607 ft., and were cemented with from 200 to 467 sacks of cement. Of these 30 wells, 18 used 7-in. O.D. and 12 used 5½-in. O.D. casing. These oil strings were cemented with from 650 to 1300 sacks of cement. Of these same 30 wells, 23 were completed with 2½-in. tubing and 7 were completed with 2-in. tubing. The tubing is generally run to or below the top of the formation.

Completion of the wells is a simple problem, and the well hook-ups and surface equipment required for the operation of the well after completion is simple in design.



A large majority of the wells in the West Edmond field are being completed using stack type heads and shop fabricated christmas trees. The trees are 2 in., 2½ in., and 3 in., the 3-in. trees being in the majority. Flow lines are 3 in. and 4 in. in diameter. In general the separators are 36 in. by 11 ft., 125 lb. working pressure. However, quite a number of used separators are in service, and they vary in size from 5 ft. by 15 ft. to 7 ft. by 22 ft. The tank batteries have been more or less standardized as follows: 80 acre lease, 3 Hi 500 bbl. tanks; 160 acre lease, 4 Hi 500 bbl. tanks. A few operators have standardized all tank batteries, using 1000 bbl. bolted tanks as follows: 80 acre lease, two 1000 bbl. tanks; 160 acre lease, three 1000 bbl. tanks.

The Chudacoff-Meeker well is the only one in the field on which a heater-treater system has been required for handling cut oil. It consists of a volumetric heater and 6 ft. by 20 ft. welded flow tank.

Several practices in the field might be of interest. This is probably the first major pool that has been developed using bulk cement. In view of the shortage of skilled help this has been a boon to the operators and drilling contractors in the field.

One large acid job has been attempted in the field. On this well the casing was set on top of the Bois d'Arc section and the well later treated with 10,000 gal. of acid. The well went on a surface vacuum before the acid job was completed and took a considerable quantity of load oil. After this treatment the well failed to flow and required swabbing for several days before returning to normal production. Although this treatment appeared to obtain a nice increase in productive capacity, it definitely indicated that at this stage of development of the field acid treatments of this size were not especially beneficial.

Only a few wells in the field have been given a second acid treatment. There are several cases in the field where the formation did not break down while taking the initial 1000 gal. of acid, and it has been found that a treatment of this kind usually recovers from 50 to 100 bbl. of rotary mud and from 150 to 200 bbl. of drilling water. In a group of 26 recent completions, 19 were acidized with 1000 gal.; 1 with 2000 gal.; 1 with 2500 gal., and 5 were put on production without any treatment. One well in the field was washed with a 4000 gal. treatment of kerosine. This treatment was not followed by any noticeable increase in production.

There have not been any caliper logs run in the West Edmond field. However, a number of temperature surveys have been run after cement jobs, and these show a fill-up of approximately 25 per cent can be expected on the average oil

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string cement job. There are large shale bodies in the Pennsylvanian section above the Bois d'Arc producing formation, and these have a tendency to wash out badly and, in several places, large concentrations of cement are reflected in these washed-out cavities by temperature surveys.

▼ **Bottom hole pressures.** A bottom hole pressure test was taken on the discovery well within a month after its completion. It showed a pressure of 3110 lb. per sq. in., corrected to a minus datum of 5864 ft. Bottom hole pressures have been taken on key wells in the field at periodic intervals since this time.

Illustration 8 shows the last bottom hole pressures taken in August, 1944, at which time the average of the 42 wells tested was 2800 lb. per sq. in. The map shows a rather uniform drop in pressures in the older producing areas around the discovery well. The erosional valley previously shown, which completely cuts through the Bois d'Arc producing section, and the fault that runs east and west through the field are shown on the pressure map for reference. The valley intersects the fault at its west end and the two completely enclose an area in Sections 28 and 29, Township 14 North, 4 West, in which the bottom hole pressures have shown an unusually rapid rate of decline. This rate of decline probably can be attributed to the lack of communication of this isolated area with the other producing areas in the field. The unusually low pressure area centering in Section 16, Township 14 North, 4 West, can possibly be attributed to a local, fairly tight Bois d'Arc section.

The north and south portions of the field appear to be definitely separated by the erosional valley. It is too early yet to say exactly what effect this will have on bottom hole pressures in that part of the field north of the valley, as compared to that part south of the valley. As the field is produced, a differential in bottom hole pressures should develop in the two areas. This differential should be influenced, if the daily per-well rate of withdrawal in the two areas remains the same, by the thickness of the effective pay section in the Bois d'Arc.

The rate of decline of bottom hole pressures coupled with the history of water encroachment to date, fairly well establishes the West Edmond field as a gas drive type pool. If the oil in the reservoir is saturated with gas, which it seems fairly safe to assume, there is a possibility of the development of a gas cap, or gas caps, in the reservoir as the bottom hole pressures are lowered. As no single porous zone in the Bois d'Arc section is probably continuous over the entire field, and because it is probable that there are a number of porous zones with limited areal extent, the question of the development of free gas within the pool is an interesting one. The data available at this time from gas-oil ratio tests do not indicate the development of any gas-cap areas, with the possible exception of the area with low pressures previously described as isolated between the erosional valley and the fault. This area should serve as the laboratory for the entire field in that the decline in pressures and production should be much more rapid than in the field as a whole, and the same production characteristics that develop in this small area should be repeated at a much later date in the remainder of the field.

▼ **Water encroachment.** There are now 10 oil wells in the West Edmond field producing water. There is an eleventh well that made some oil with water but which was never successfully completed as an oil well. There are several wells lying west of the limits of oil production in the field that have reached the Bois d'Arc member and found salt water. The 10 wells making water are all located in Section 31, Township 14 North, 4 West, and Section 6, Township 13 North, 4 West. These wells are all near the west limits of the field and are structurally low. Of the 10 wells, 8 are flowing their production and 2 are on the pump. The locations of these water wells are shown by large circles on the structural map of the field (Illustration 6).

The Chudacoff-Meeker No. 1, NE NW 6-13n-4w, was the first oil well in the pool to show water. On December 4, 1943, this well was perforated from 7033 to 7034 ft. after setting pipe through the Bois d'Arc section. The well made some oil but immediately filled with salt water

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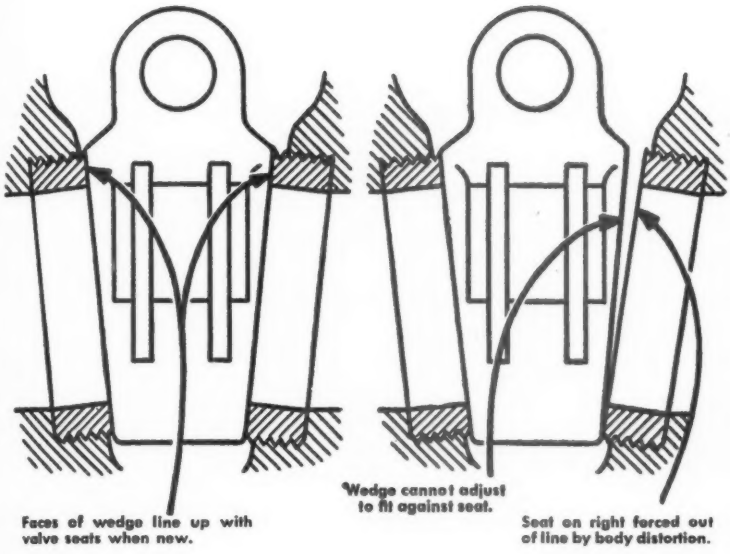
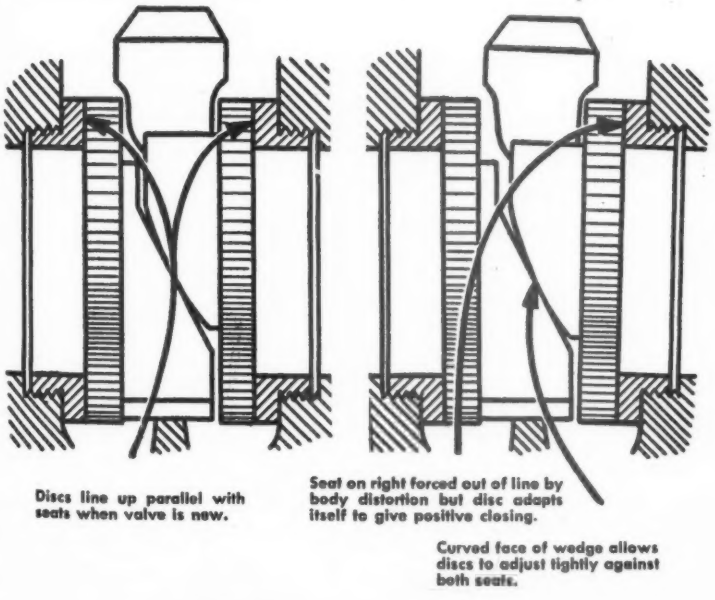

Faces of wedge line up with valve seats when new.
Wedge cannot adjust to fit against seat.
Seat on right forced out of line by body distortion.

ABOVE—What happens before and after a taper seat gate valve is subjected to body distortion is shown in these somewhat exaggerated diagrams.

BEFORE AND AFTER

BELOW—How the Darling Fully Revolving Double Disc Parallel Seat gate valve continues to give positive closing despite body distortion.


Discs line up parallel with seats when valve is new.
Seat on right forced out of line by body distortion but disc adapts itself to give positive closing.
Curved face of wedge allows discs to adjust tightly against both seats.

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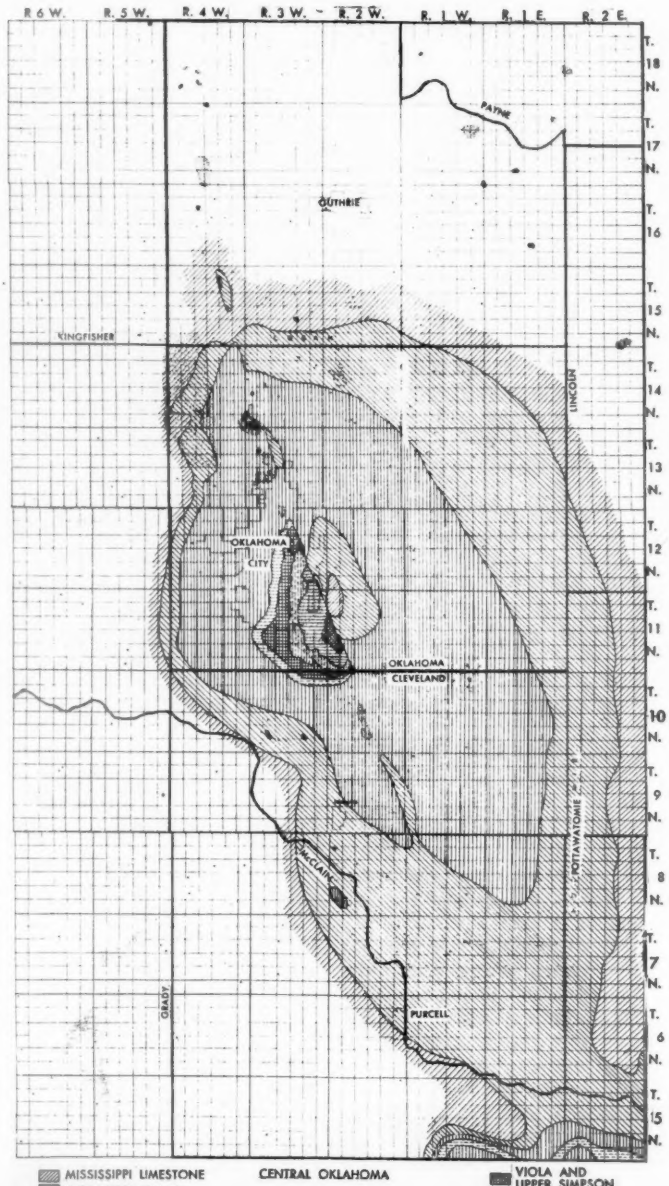
to within 500 ft. of the top. It was squeeze cemented, and on December 13, 1943, was perforated from 6943 to 6985 ft. At this depth it flowed and swabbed 30 bbl. of oil with 270 bbl. of mud and water in 24 hr. After testing the well was again squeeze cemented, and on January 5, 1944, perforated from 6932 to 6969 ft. The well was acidized with 500 gal. and flowed 1400 bbl. of oil in 14 hr. with no water. However, the well soon began to show water. The testing of this well and data on nearby wells indicate the original water table in that portion of the field south of the erosional valley was between a minus 5904 and minus 5925 ft. The Meeker No. 1 is still flowing its production and is producing about 350 gross bbl. per day, of which 150 to 160 are oil and the remainder water.

Of the 10 oil wells making water, 4 started making salt water at the time of completion; 2 started producing water at the end of one month after completion; 2 in approximately 3 months, and 2 in 6 months after completion. This entire group of 10 wells is producing now approximately 500 bbl. of salt water per day. Most of the wells are still capable of producing their daily oil allowable of 200 bbl. per day.

Although the total water production from the field is on the increase, and will probably continue to increase as additional west edge, low structural wells go to water, the production of water in some of the older wells is showing a tendency to level off.

As previously stated, it appears now that the principal energy for lifting the oil in the West Edmond field will come from the gas dissolved in the oil itself and not from water intrusion. There should never be a serious water production problem in the West Edmond field, and undoubtedly many of the wells will be produced to exhaustion without making water. Most of the wells in the West Edmond field have completely penetrated the Bois d'Arc section. In the producing area only the 10 wells on the west edge of the field have encountered water. There is, therefore, no water table underlying the pay section of the West Edmond field over a large percentage of its productive area. Only a comparatively narrow fringe along the west edge of the field will have water below the oil in the pay section.

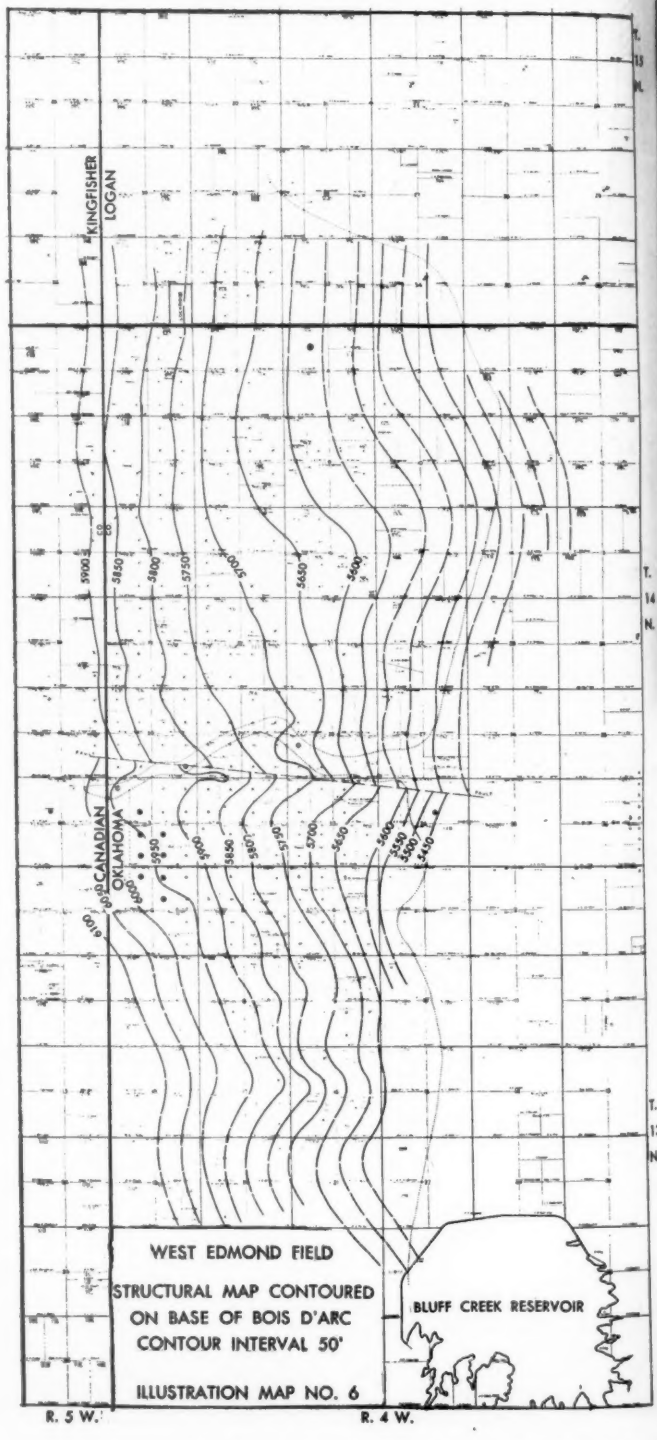
At this time there is considerable speculation on whether the water table will be lower north of the erosional valley than south of it. To date no well making oil north of this valley has reported water. There is not yet sufficient information available to determine whether



CENTRAL OKLAHOMA

PRE-PENNSYLVANIAN AREAL MAP

ILLUSTRATION NO. 5



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clean oil production may be expected at a lower level in the north portion of the field.

▼ **Drilling practices.** On September 29, 1944, there were 120 heavy duty drilling rigs operating in the West Edmond field. Though the average total depth of the producing wells is 7100 ft., the deepest major pool ever developed in Oklahoma, there have not been any difficult drilling problems to overcome. The outstanding features of the drilling campaign are the unusually large concentration of heavy duty drilling rigs and the remarkable record achieved by the drilling contractors under war-time conditions.

The development of the field started on a rather modest basis—there being only about 10 rigs in the field 4 months after the discovery well was completed. However, as the productive possibilities of the field became more evident, the drilling program was stepped up until by the spring of 1944 the demand for rigs had exceeded the supply. Under the pressure of war-time demand for oil and its products each company has attempted to develop its leases as rapidly as possibly. Open competition for drilling rigs among the 28 operators in the field soon developed. This great demand for rigs caused many drilling concerns to search their yards for any equipment of sufficient size to drill to 7100 ft. Many steam rigs that had not seen service for 10 or 12 years were put back into operation; also, many pieces of equipment that had been shelved as obsolete were put into service largely because of the inability of contractors to obtain new replacements and repairs. Many rigs have been brought in from nearby states until at this time there is probably a larger number of rotary drilling rigs in the West Edmond field than anywhere else in the world. Still there are not enough.

There are all types of drilling rigs in operation in the field. They vary from the latest model power to some of the earliest type steam rigs. In addition, many drilling rigs have been put in service in the West Edmond field that were not designed for drilling to depths of 7100 ft. In view of the many types and of the quality of the rigs being operated, the difficulty of procuring replacement and repair parts, the poor quality and inexperience of many drilling crews and maintenance units, and the critical shortage of drill pipe and tool joints, the drilling record in the West Edmond field is rather remarkable.

The general practice for drilling wells in the West Edmond field is to dig shallow boarded-up cellars, usually 8 by 8 by 4 to 8 ft. deep, erect steel 122-ft. derricks on concrete or wooden corners, and dig the usual standard size circulating and reserve pits. The reserve pits are usually used for circulating until a depth of around 5000 ft. is reached. Most holes drilled below the surface pipe are 9 in. in diam., a few being 8¾ in., where 4½-in. drill pipe is used. On those wells where it is planned to set a 5½-in. oil string of casing, occasionally 7⅞-in. holes are drilled, using 3½-in. drill pipe. Rock pits are used throughout.

▼ **Mud.** The discovery well was drilled in the winter of 1942-43, and during most of its drilling the weather was unusually cold for Oklahoma. Much trouble was encountered with the drilling mud and a caving hole. It was thought at the time that the caving hole and mud difficulties were largely due to freezing of the mud and a lack of sufficient drilling water to mix mud properly. It was anticipated that the drilling time of 65 days under the surface pipe to the base of the Hunton limestone on the discovery well could be reduced substantially under better operating conditions. However, as subsequent wells were drilled, it was found that most of the same mud difficulties were encountered. These difficulties were found to be caused by a high concentration of calcium salts, particularly calcium sulphate. This high concentration was principally due to contamination of the mud by water from shallow sands and partially to the high concentration of these salts in the surface water being used for drilling. The presence of these salts in the mud causes a low yield of drilling mud per ton of bentonite, and, in addition, causes a high water loss. The average well in the West Edmond field requires the use of approximately 25 to

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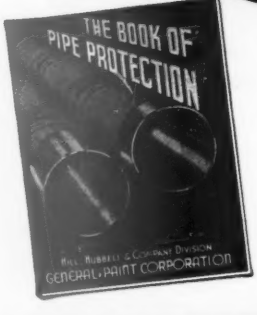

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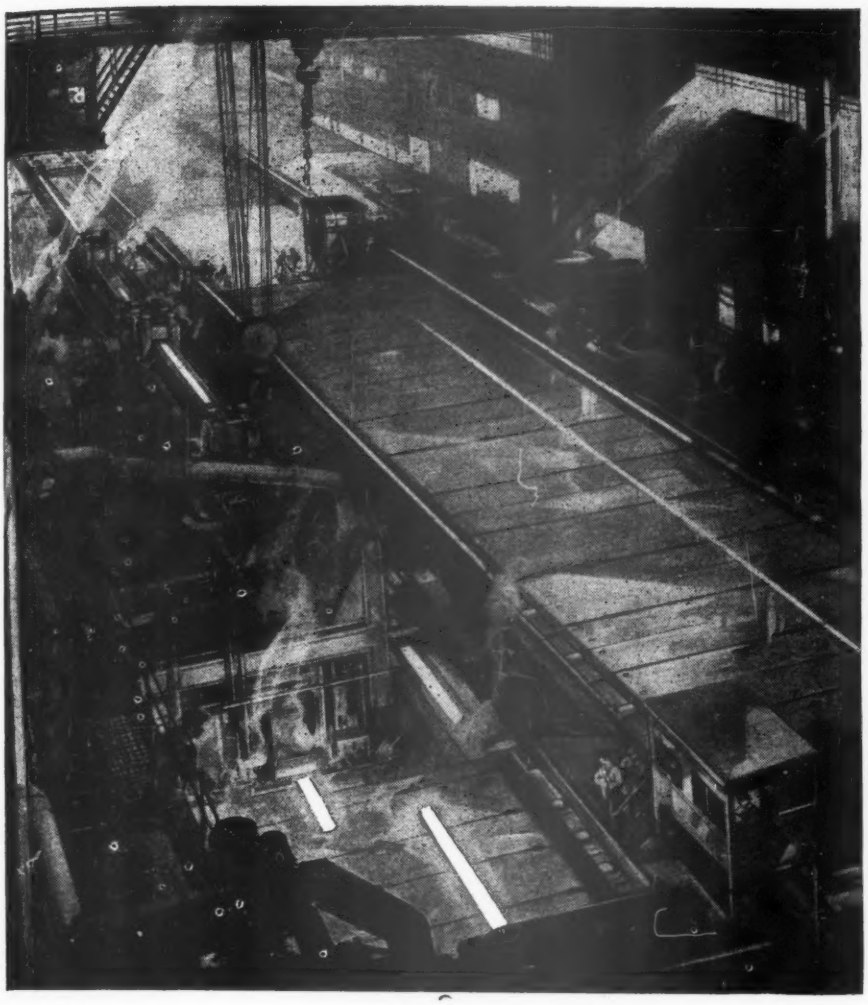

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Watching the white-hot bars of steel run the course of this modern continuous bar mill—going faster and faster, growing longer and longer—stimulates pride in war steel production in America and gives assurance of an abundance of steel for use in a world at peace.

For this unique J&L bar mill — as well as other bar mills throughout the industry — is as adaptable as steel itself; the strongest, most versatile metal. Without change of pace, the rhythm of its rolling took up the song of steel in battle: steel for planes, tanks, shells, ships and guns.

At war's end these mills will keep on rolling steel—without pause for conversion—steel bars for automobiles, for railroads, for industry, for farms—new and better steels for daily living and employment.

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Steel mill music is a thunderous, rumbling of overtones and undertones in a big, modern rolling mill that blend into a roaring symphony. To a visitor, it is just a deafening noise, but to the skilled crews that operate the mill it has a definite rhythm. If the workmen at their posts hear the faintest dissonance, each man is instantly alert to find out quickly what is causing the discord, as it may signal something amiss. Ears trained by years of listening to steel mill music can spot an off-beat in the great rhythmic noise as quickly as a conductor can spot one in a big orchestra.

World record for steel bars from any bar mill, 44,125 tons in one month, was rolled on the Jones & Laughlin No. 18 mill (see illustration) in January this year, a tribute to highly skilled workmen who operate it, and to J&L engineers who in 1931 pioneered in designing the new type mill.

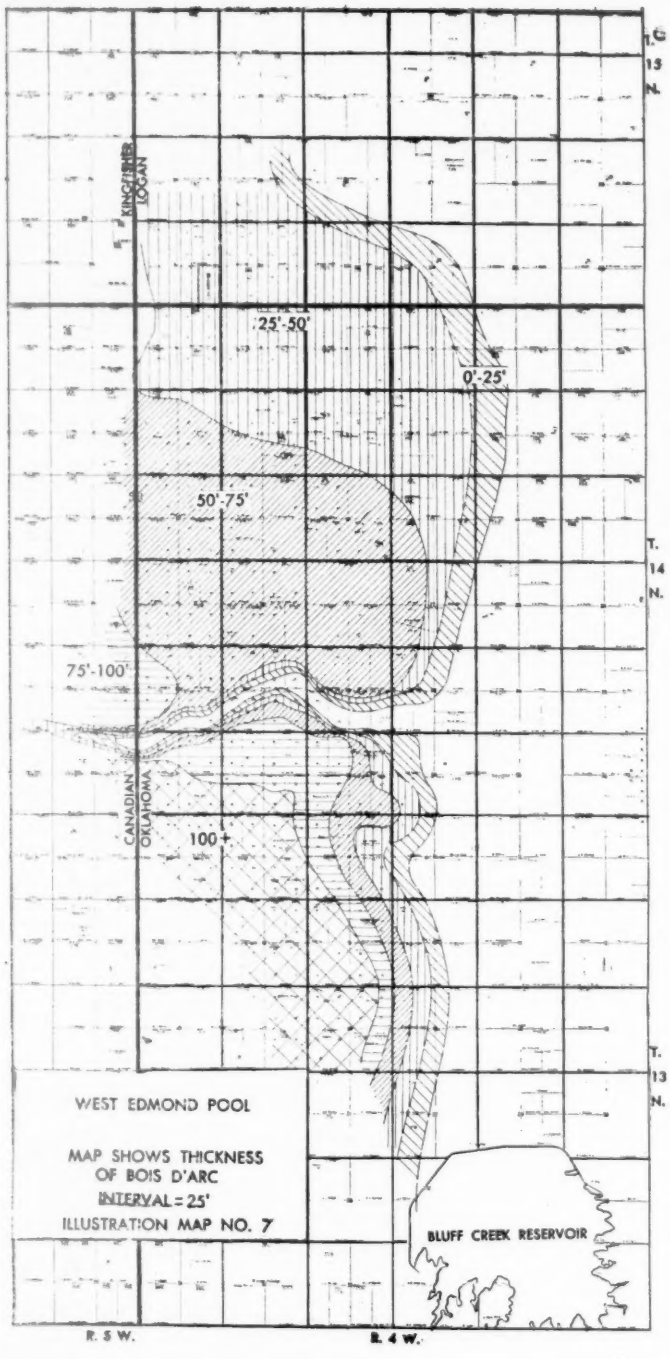
A deep rose-red glow illuminates rolls, men and interior of this unique J&L 14-inch bar mill as red-hot billets being rolled into rounds, flats, hexagons, squares and special shapes speed through several stands of rolls on their way up and down and across the mill's great expanse (large enough to cover five football fields). This mill is so vast that as many as twelve steel sections are in process at one time — totaling at finish as long as ½ mile — and so fast that time from billet to finished bar is less than two minutes.

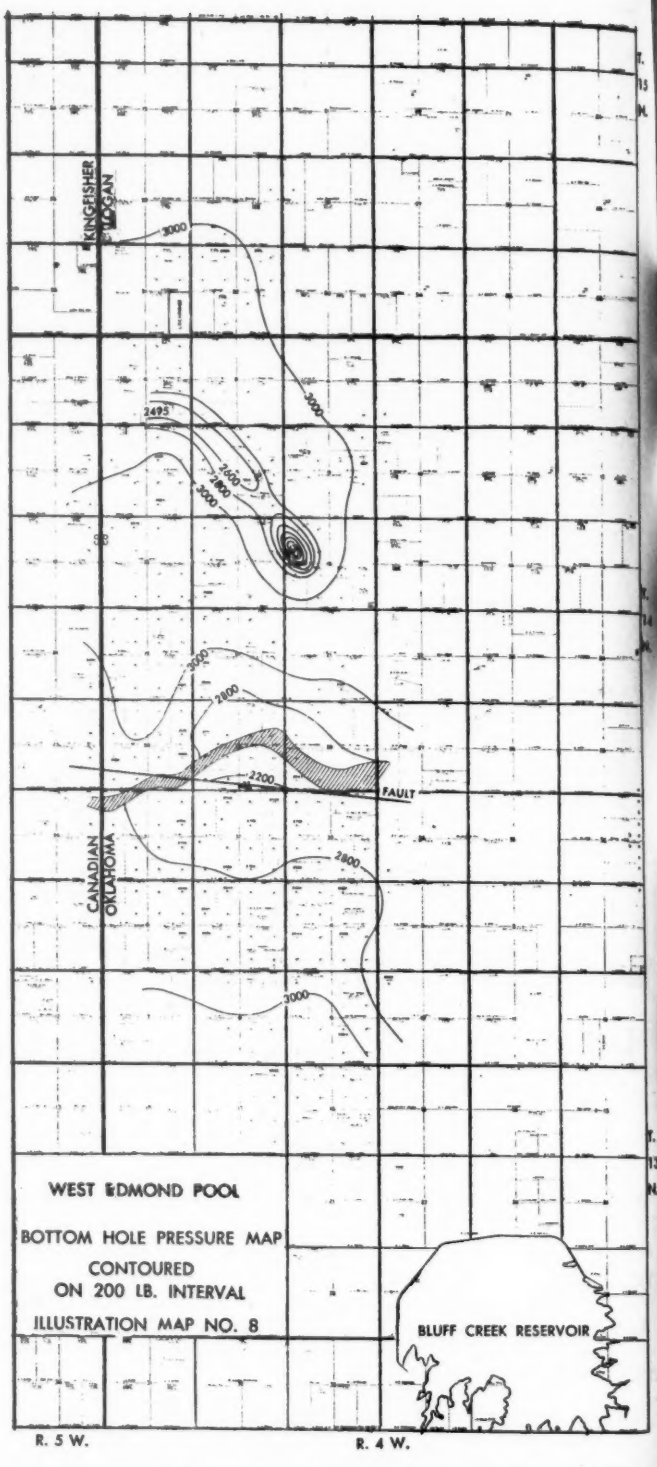
Iron works on a flat boat is what the astonished citizenry along the Monongahela River in 1850 saw being pushed by a steamboat down the 60 miles from Brownsville to Pittsburgh. The iron works belonged to twenty-six year old B. F. Jones. He had purchased the plant with his earnings as a partner in a canal boat freight service. Young Jones dismantled his furnaces and mill and transported them to Pittsburgh, foreseeing the development there. This was the beginning of the Jones & Laughlin Steel Corporation, today fourth largest steel producer.

Conestoga freight wagons, and canal boats transported to eastern markets the puddled iron bars, flats, plates, shapes, bands, cold rolled iron bars, and cut nails that in the 1850's were the pioneers of a long line of J&L products to follow.

Stoutly Dutch-built in a valley in eastern Pennsylvania once occupied by Conestoga Indians, the blue and red Conestoga wagons with rakish, overshot canvas tops, were pulled across the rugged trails of the Alleghenies by 4- and 6-horse teams hauling freight.

Stogies, a popular smoke to this day in the Pittsburgh district, were long, thin, black cigars brought west from tobacco plantations in eastern Pennsylvania by Conestoga wagon drivers, who hauled back iron products. These stout smokes were called "Conestogie" cigars, soon shortened to stogies.





30 tons of bentonite. Some chemicals are used, principally tannic acid, soda ash, and phosphates. The usual practice is to drill with water and natural mud until a depth of 5000 to 5500 ft. is reached, at which time the use of artificial mud is begun. The problem of low yield and high water loss has been largely solved in the field by chemically treating the mud with the chemicals previously mentioned, plus sodium silicates. Also, good drilling water is now available and this has helped considerably. The usual practice is to carry mud 9.7 to 10 lb. per gal., with a viscosity from 40 to 43 seconds per quart, and with a water loss range of 15 to 20 cc.

▼ **Water.** One of the early drilling problems in the West Edmond field was the water supply. Deer Creek traverses the field from the southwest corner, Township 14 North, Range 4 West, to the northeast corner of the same township. The discovery well was drilled in the valley of this creek, and all early development was in the creek valley or nearby. In the spring of 1943 the creek was flowing a large volume of water, and all the drilling contractors in the field used it for drilling purposes. Steam rigs soon began to have boiler troubles. Analyses of the water showed a hardness of 40 to 60 grains and a high concentration of calcium sulphate. In the late summer of 1943 this source of water began to fail, due to lack of rainfall, and several water wells were drilled in the field to the Garber sandstone, found from 200 to 700 ft. in depth, which is the source of very good water in the Edmond field about 4 miles east. The Garber sandstones were found to carry large volumes of water, but this water, too, was hard and carried about the same large concentration of calcium sulphate as did the surface water. As there was no other water available in the field, the drilling contractors continued to use what surface water was available, plus water from the wells in the Garber sandstone. As a consequence, the operators of steam rigs found that in spite of diligent and expensive treating of the water a battery of boilers would complete only about one well without requiring an overhaul and repair job. Several boiler explosions occurred in the field.

There are now 5 water systems in the field. Four of these systems bring water from wells drilled to the Garber sand-

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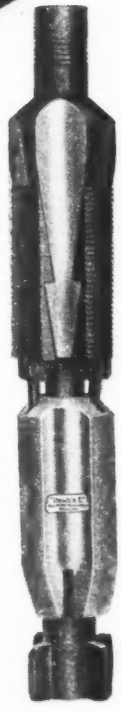

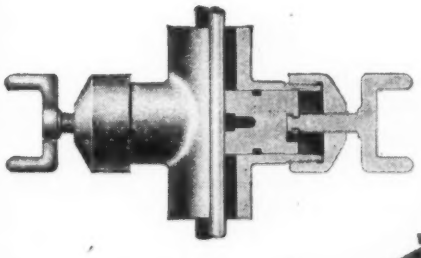

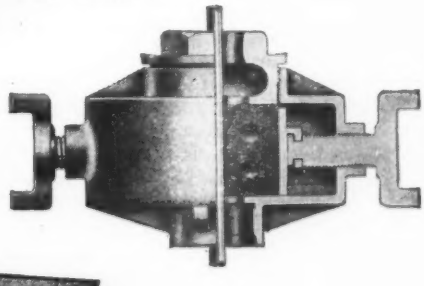

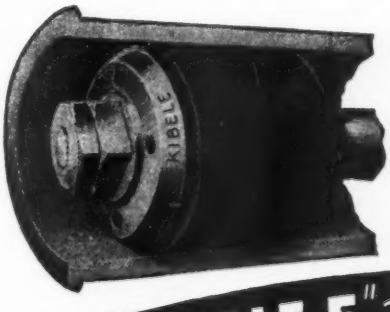

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stone, approximately 4 miles east of the field. This water has a hardness of about 2 to 3 grains, and is exceptionally good drilling water. One of the systems obtains water from the diversion canal connecting Oklahoma City's Lake Overholser and the new Bluff Creek water project. This water has a hardness of approximately 12 grains, and is a fairly good drilling water. Some contractors are still using the available water in small ponds and lakes scattered through the field. Generally, however, the water problem in the West Edmond field has been solved and no difficulty should be encountered from this source in the drilling up of the field.

There are no upper oil and gas zones, and practices have been on inside proved locations to drill without the use of blowout prevention equipment, although some operators do require it.

The average well in the West Edmond field requires approximately 14 days to move in, rig up, spud, set surface pipe and wait on cement, and 57 days to drill the hole under the surface pipe to the total depth. The general practice in the field now is to complete the wells with rotary, and the rig must remain over the location until the cement has set on the production string. Then a bit is run on the end of the tubing and the hole cleaned out below the perforating depth. The tubing is then pulled, the casing perforated, the tubing rerun, the mud circulated from the hole, the well acidized, and washed in. This operation requires an average of 7 days additional. The overall time from the date when the rig first starts to move in until the well is completed and the rig is torn down ready to move off is an average of about 77 days.

The drilling of the hole to total depth requires an average of 42 bits per well. The best drilling time in the field, of which there is a record, is 30 drilling days under the surface pipe. The best bit record in the field is 30 bits. Most bits are run approximately 22 or 23 hr. The average footage drilled per bit is about 170 ft.

▼ **Hazards.** There have been a number of fishing jobs in the West Edmond field. By far the largest percentage of these have been twistoffs of drill pipe. There have been a few key seated holes, and some stuck drill pipe. In those holes where mud is kept in good condition, twistoff fishing jobs are usually cleaned up in 24 to 48 hr. Most twistoffs occur below a depth of 6000 ft. The cavities developed in the large shale bodies, both under and above the Checkerboard lime, have a direct bearing on the number of twistoffs in the field. The formations become harder in the lower part of the hole. If too much weight is carried in an attempt to make fast time through these formations, twistoffs may result where the pipe buckles in the washed out shale sections.

The Oswego lime is found at about 6500 ft., and is approximately 100 ft. thick. This lime is fractured and has a tendency to break up into fragments, which fall in on top of the bit after the lime has been penetrated. Attempting to free the hole of these boulders has occasionally led to twistoffs.

Of the fishing jobs in the field, a small percentage have not been cleaned up and it has been necessary to plug back and whipstock. At this time there are 3 wells in the field drilling by after whipstocking.

Beds overlying the West Edmond production are very flat-lying and no particular difficulty is encountered in drilling straight holes. Most operators require the deviation from vertical to be within 4 deg. and some have a maximum of 3 deg. There are a few cases of crooked holes in the field, which are largely due either to setting the surface pipe in a crooked hole, or the development of a crooked hole in crowding the drilling in an attempt to make fast time. Most of these crooked holes occur in the soft digging formations in the Permian above 2000 ft. In one or two cases, crooked holes in these soft red beds has later led to key seating.

Slope tests are run on most of the wells at either 250 or 500 ft. intervals, using any one of several of the standard devices.

In some of the early wells, trouble was experienced with lost circulation, especially when drilling either the Oswego or Hunton lime. Control of the weight of the mud while drilling in the lower part of the hole has generally eliminated this difficulty.

The drilling price in the field for the first few wells after completion of the discovery well was as low as $4.75 per ft., with the drilling contractor supplying everything necessary for the drilling of the hole except the surface pipe, cement, and cementing service. Prices soon rose to $5.50 per ft. with the operator supplying the fuel and all casing and cement. As more drilling experience was obtained and it became evident that the wells could not be drilled as rapidly as was first anticipated, and, as competition developed among the operators for rigs, the price rose until at present the average contract in the field is $7 per ft. with the operator supplying the fuel, water, derrick, cellar, pits and mud, in addition to all pipe and cement.

Very little coring has been done in the field and that that has been attempted in the Bois d'Arc formation has largely resulted in poor recovery. There is a well in the field now that set pipe on top of the Bois d'Arc, and is coring through it using the reverse circulation method.

There have been no blowouts in the field while drilling, and there have been no fires.

▼ **Conservation practices.** The West Edmond field is the only Hunton lime pool in the State of Oklahoma that has had its production and development closely and efficiently supervised by the Conservation Department of the State Corporation Commission from the time of completion of the first well. The State Conservation Department followed closely the drilling of the discovery well and put into practice applicable conservation measures immediately on completion of the well.

The Wagner No. 1, discovery well, was drilled on a 10-acre location. However, on July 19, 1943, the commission issued its first Order, No. 16510 in Cause CD No. 885, "which order defined the boundaries of the probably productive area of the Hunton lime, common source of supply in the West Edmond field, and established 40-acre well spacing and/or drilling units for its development, together with rules and regulations for drilling and operating of all wells therein." On December 16, 1943, the commission issued its Order No. 16782, which amended the rules for the drilling and operation of wells as set out in Order No. 16510, but, except for the amended portion, left the original order in full force and effect. On April 27, 1944, the commission issued its Order No. 17007 in Cause CD No. 885, again amending the original order insofar as the boundaries of the probably productive area of the Hunton lime, common source of supply in the West Edmond field, was concerned, but leaving in force and effect all the original provisions of Order No. 16510, as amended by Order No. 16782. This order concisely sets out the rules and regulations promulgated by the conservation department and is considered a good example of adequate but not restrictive control of the development of an important oil field, and is therefore quoted in its entirety:

"IT IS HEREBY ORDERED by the Corporation Commission of the State of Oklahoma as follows:

"That Order No. 16510, as amended by Order No. 16782, be, and the same is hereby, amended to read as follows, to-wit:

"1. That forty-acre well spacing and/or drilling units, in the form of a square be, and the same are hereby, established for the development of the Hunton Lime, common source of supply of the West Edmond field, the probable productive area of which underlies the following described lands in Oklahoma, Logan, Canadian and Kingfisher Counties, State of Oklahoma, to-wit:

"East half of Township 13, 14 and 15 North, Range 5 West; and
North half of Township 11 North;
All of Township 12 North;
All of Township 13 North, except Sections 1, 12, 13, 24, 25 and 36;
All of Township 14 North, except Sections 1, 12, 13, 24, 25 and 36;
All of Township 15 North, except Sections 1, 2, 3, 10 to 15, both inclusive, 23 to 26, both inclusive, and 36;
All in Range 4 West, and containing 121,600 acres, more or less,

which area may be extended from time to time by the drilling of additional wells, it being the intention to cover all of the productive area of said common source of supply, and any wells drilled into said common source of supply outside the area above described shall be drilled in the manner and according to the pattern herein prescribed.

"2. That each 160-acre quarter-section shall be divided into four equal parts in the form of a square, all as shown by Exhibit "A" attached hereto and made a part hereof; that each well drilled in

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—*Signal Corps Photo*

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said common source of supply shall be located in the approximate center of a forty-acre drilling unit, taking into consideration the topography of the land and any surface improvements or other obstructions.

"3. In event a producing well is completed in a unit of which the area is owned by two or more persons, the rights and interests of those interested therein shall be determined, adjusted, and controlled by subsection (c), Section 3, Article 1, Chapter 59, Session Laws of Oklahoma, 1935, which is hereby by reference made a part hereof to the same extent as if set out herein.

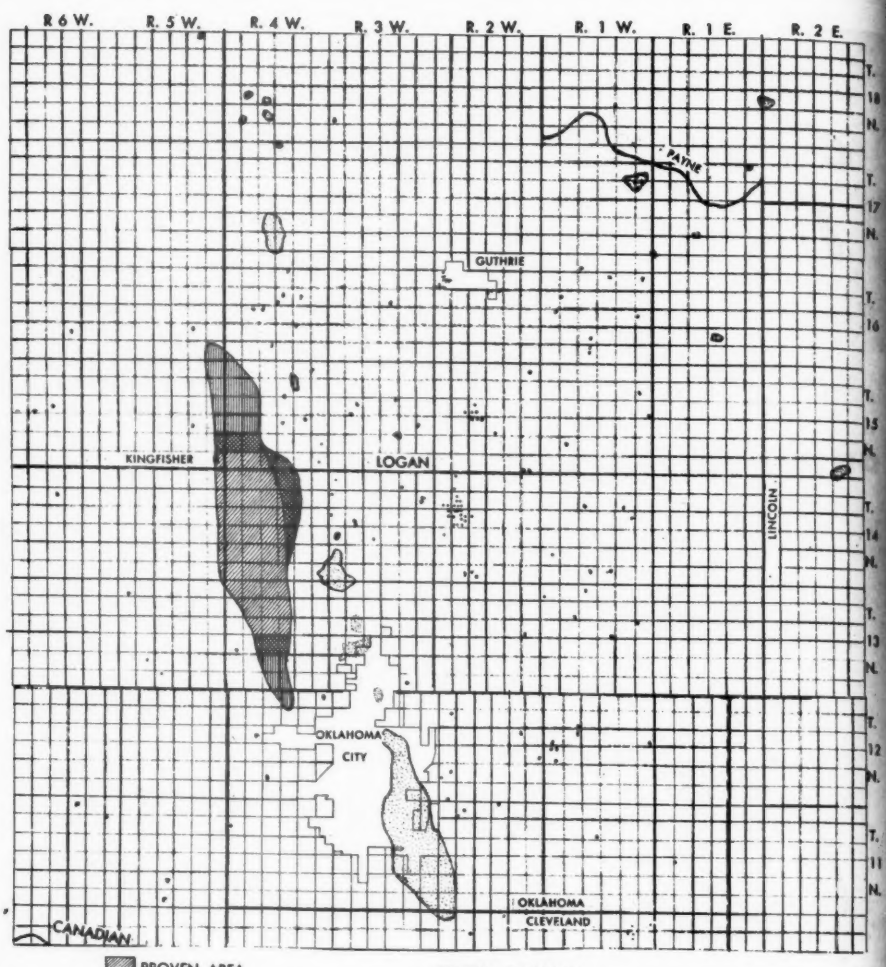
"4. The following rules and regulations shall be followed in the drilling and operation of all wells drilled to the said Hunton Lime formation, to-wit: Surface casing shall be set at a depth of at least 300 feet, and cemented from top to bottom; and a flow string shall be set not higher than the top of the producing formation and cemented with sufficient cement to fill the calculated annular space behind the casing to a point not less than 2700 feet above the casing shoe. Said flow string shall test at least 2800 pounds. Each well shall be tubed with not to exceed 2½-in. tubing, and all production shall be through such tubing, which shall be set not higher than the top of the producing formation and shall be plugged at the bottom and the lowest joint perforated. All well connections shall be not less than 3000 pounds test. No well shall be permitted to produce at a gas-oil ratio in excess of 2000 cubic feet of gas to 1 barrel of oil, measured at 4 oz. pressure base above atmospheric pressure, corrected to 60° F. and specific gravity of .70. Gas-oil ratio tests shall be taken by or under the supervision of the Oil and Gas Conservation Department on each well in said pool at least once each 90 days, during which test the well shall be produced in the same manner as it normally produces its current allowable. The Conservation Officer shall notify the operator 10 days prior to the testing of a well, and at the time of the test the operator shall have the well properly equipped and in proper condition for taking such test. When a well is abandoned a cement plug shall be set at the base of the Garber Sand so as to protect all fresh water sands above that point.

"5. All provisions of Order No. 16510, as amended by Order No. 16782, except as specifically amended by this order, shall remain in full force and effect unless otherwise ordered by the Commission.

"DONE AND PERFORMED by the Corporation Commission at its offices in the Capitol Office Building, Oklahoma City, Oklahoma, this 27th day of April, 1944.

CORPORATION COMMISSION OF THE STATE OF OKLAHOMA.

(Signed) Reford Bond,
Chairman.
Ray O. Weems,
Vice-Chairman.
Wm. J. Armstrong,
Commissioner.



CENTRAL OKLAHOMA
WEST EDMOND FIELD
POSSIBLE PRODUCTIVE AREA
ILLUSTRATION NO. 9

ATTEST:
(Signed) Carl B. Mitchell,
Secretary.
SEAL"

The discovery well, under a formula worked out approximately 2 years ago by the conservation department, was given a discovery allowable of 94 bbl. per day for a period of one year over and above the regular allowable for the other wells in the pool. On this basis the Wagner No. 1 well was allowed to produce 394 bbl. of oil per day from May 5, 1943, until May 1, 1944. During this period other wells in the field were allowed to produce 300 bbl. per day. On May 1, 1944, the daily allowable of the field was cut back to 200 bbl. per well per day by order of the corporation commission, and at this time the allowable of the discovery well became 294 bbl., which allowable continued until May 5, 1944. Since May 5, 1944, the allowable of the discovery well has been the same as other wells in the pool.

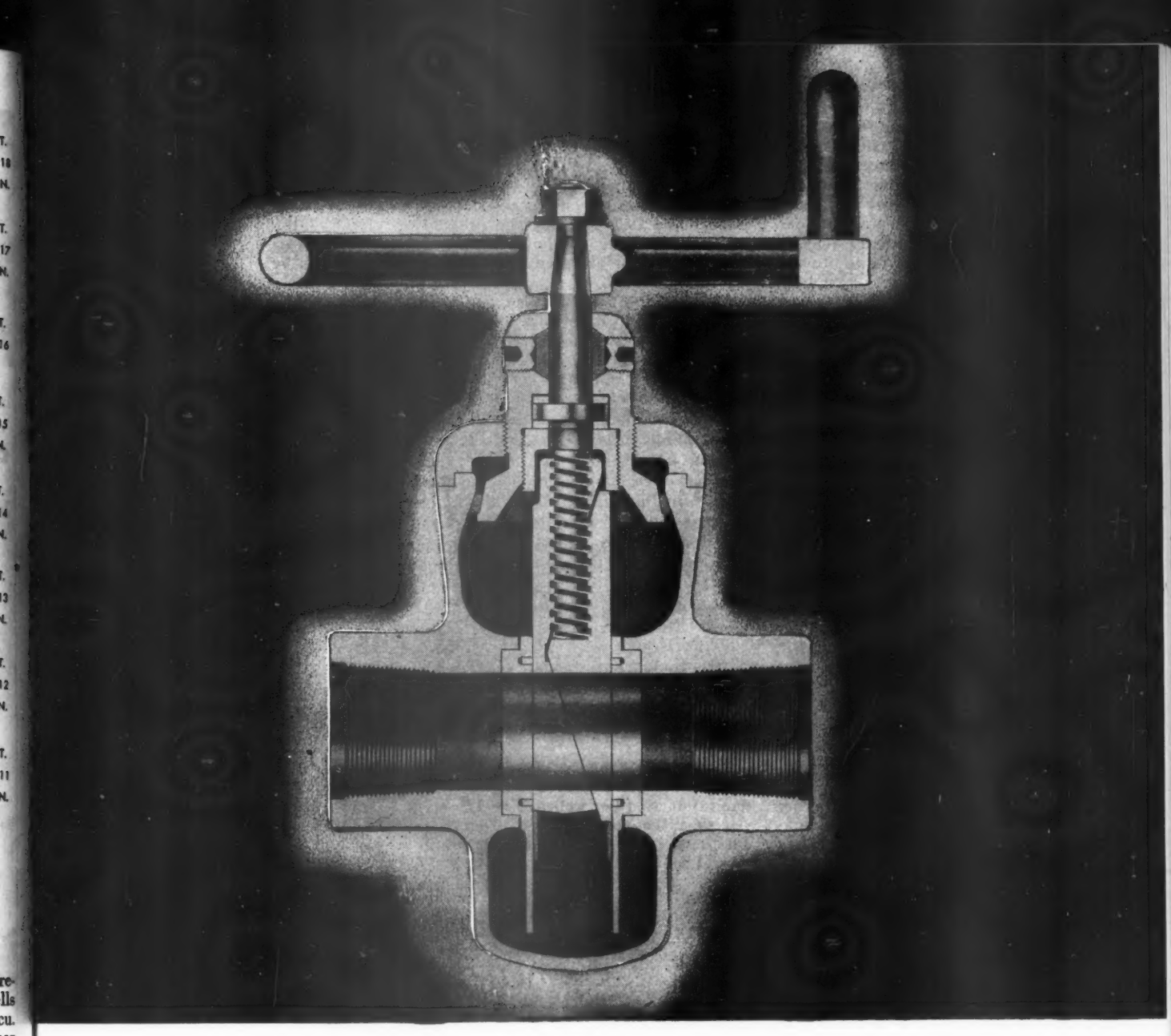
The conservation department has acquired its own field equipment for making tests, and the petroleum engineer for the department has kept a periodic check on bottom hole pressures, gas-oil ratios, water production, casing programs, and other pertinent data in the field. The conservation department at this time is preparing to run a new series of gas-oil ratio tests with the intention of restricting the production of those wells where the gas-oil ratio exceeds 2000 cu. ft. per bbl. Effective with the September allowable, any well with a ratio above 2000 cu. ft. per bbl. will be prorated on the basis of the following formula:

"Daily allowable or productive ability (if it is not capable of making its allowable), multiplied by the allowable ratio of 2000, divided by the actual oil-gas ratio."

In other words, as an example, a well with a ratio of 4000 cu. ft. of gas per bbl. of oil would have one-half the daily allowable, or 100 bbl. of oil per day.

When it appeared, early in 1944, that the field might have a water drive and that water encroachment might be rapid if the high rate of production of 300 bbl. per well per day was continued, the conservation department recommended that the per-well production of the field be cut back to 200 bbl. per day until such time as additional data could be secured to determine more definitely the proper rate of production.

The West Edmond Operators' Engineering Association has been organized within the last 4 months and has employed a petroleum engineer and staff to assemble data and make studies of operating practices and well behaviors in the field.



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▼ **Pipe lines.** At the present time 3 companies have oil gathering systems in the West Edmond field. However, there is only one oil trunk line from the field, and the oil gathered by these 3 systems goes into this one line. Several applications have been filed with the Petroleum Administrator for War for additional pipe line outlets from the field, but to date none have been approved.

There are 2 gas gathering systems in operation in the field. One system picks up gas from the separators on the various leases and distributes it among the drilling contractors to be used as fuel in drilling operations. The second system has both a gas gathering system and a residue system in operation. The gas is picked up, put through a gasoline plant in the old Edmond field and the residue returned to the field for drilling and lease operations. At the present time one gasoline plant is being constructed in the field.

▼ **Future development.** As of September 26 there was a total of 164 wells in the West Edmond field. The spacing pattern has been uniformly 40 acres, and, consequently, there are a total of 6560 productive acres in the field assigned to producing wells as of that date. On this same date there had been a total of 12 dry holes drilled since the discovery, either in the field or immediately around it. Production has been proved over an area approximately 11 miles north and south and 2 to 3½ miles east and west.

Illustration 9 is an outline of the possibly productive area of the West Edmond field. The area is divided into proved acreage, probably productive acreage, and possibly productive acreage. The proved acreage as shown on the map totals 20,700 acres. The probably productive acreage as shown totals 6700 acres. The possibly productive acreage as shown totals 8300 acres. The grand total of all three groups is 35,700 acres. Assuming that development will continue on the present 40-acre spacing pattern, there will be a total of 892 producing wells if the area is completely developed. Substracting the 164 wells already on production and the 120 wells now drilling, or preparing to drill, there remains a total of 608 wells to be drilled.

Based on the assumption that the number of drilling rigs in the field will remain at 120 until the field is drilled up, the number of completed wells at the end of each month is estimated as follows:

1944	October	227
	November	279
	December	302
1945	January	372
	February	407
	March	459
	April	514
	May	530

Using this estimate of completed wells by months, and assuming that the average production per well will be 175 bbl. per day, the daily average production for the field at the end of each month should be:

1944	October	39,725
	November	48,825
	December	52,850
1945	January	65,100
	February	71,225
	March	80,325
	April	89,950
	May	92,750

It is interesting to note on Illustration 9 the large area that will be covered by the West Edmond pool if all the acreage estimated as possibly productive is finally drilled. To give a relative comparison of the size of the West Edmond field, the outline of the productive area of the Oklahoma City field is shown.

The total accumulated production of the field to the end of August, 1944, is 3,521,863 bbl.

Estimates as to the probable total recovery of the West Edmond field vary widely, both because of the great range in estimated per acre yields and in estimated productive area. It probably can be safely said that the total recovery from the field will exceed 100,000,000 bbl. and may possibly reach 175,000,000 bbl.

The discovery of the West Edmond field has led to a reexamination of the oil and gas possibilities of the east and north rims of the western Oklahoma basin. For approximately 200 miles around the rim of this basin, the Hunton limestone is partially or completely truncated. Consequently, the same possibilities for the development of a West Edmond type accumulation of oil and gas exist throughout this immense area.

★ ★ ★

TUBING STRAIGHTENER SPEEDS DIESEL PRODUCTION

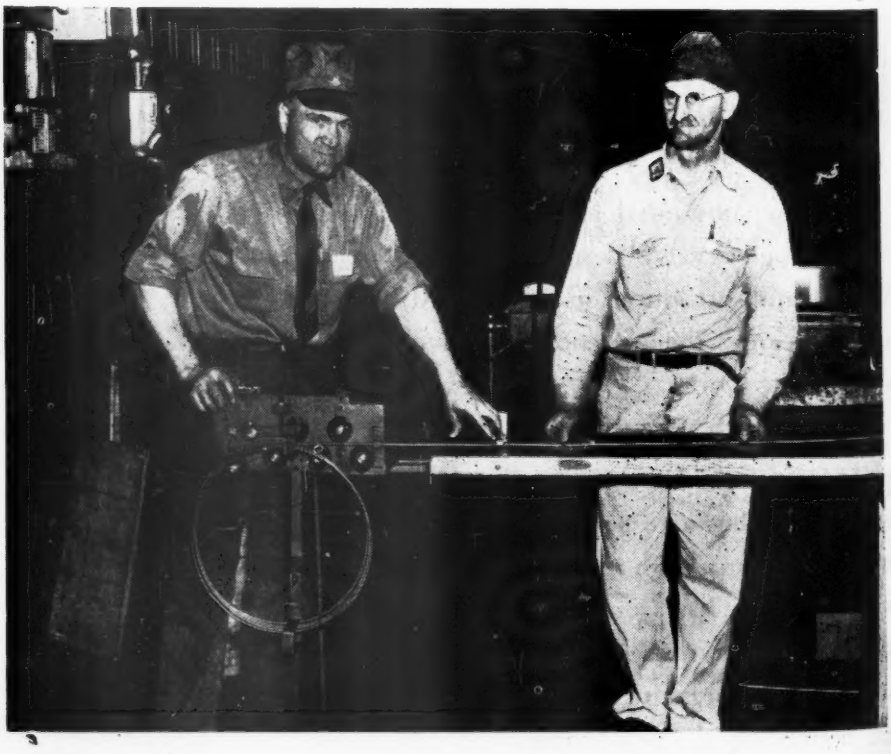
A DEVICE that solves a time-consuming operation, that of straightening rolled-steel tubing, has been devised by two employees at the Grove City, Pennsylvania, plant of The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

The tube straightener is one of the simplest of any of the labor-saving tools used in the shop. Made of a few odds and ends of metal and a series of 5 rollers, the device eliminates former hand straightening operations.

The tubing, of 1/4 in. and 5/16 in. diam., is received in large coils and previously had to be unwound as needed. straightened with a paddle, then bent and formed to fit a specific connection.

With the new device shown in the accompanying illustration the coil is simply positioned over a bracket at the side of the contrivance, the loose end is threaded through the rollers, and the tube is straightened by pulling it out along a horizontal tray where it is measured and cut off to the required length.

With nearly a mile of such tubing used monthly in the assembling of Cooper diesel engines, a tremendous saving in time and effort through the adoption of this novel machine is apparent.



THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 88

A VALUABLE and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue, 73-79, inclusive, in the January, 1944, issue, 80-82, inclusive, in the April, 1944, issue, and 83-85, inclusive, in the July, 1944, issue.

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HYDROCARBON AZEOTROPES

DATA ON HYDROCARBON AZEOTROPES*

By R. H. EWELL,† Purdue University, Lafayette, Indiana; J. M. HARRISON and LLOYD BERG, Gulf Research and Development Company, Pittsburgh, Pennsylvania

THE separation of petroleum hydrocarbon mixtures into their pure constituents is a problem being rapidly developed. Benzene, toluene, butadiene, and styrene are a few of the important industrial chemicals which are recovered from petroleum or made from its constituents. A great many more are present and remain to be recovered: ethylbenzene, xylenes, cumene, and cyclohexane to name only a few.

While these hydrocarbons exist in crude petroleum or can be readily made from it, they are invariably accompanied by a large number of compounds of similar boiling point. One of the principal problems confronting the petroleum technologist in the production of pure hydrocarbons is that of separation of the desired component from the hydrocarbon mixture.

Among the methods available for separation of close boiling compounds is azeotropic distillation. In order to investigate efficiently the separation of hydrocarbons by means of azeotropic distillation, it is desirable to have available as much vapor pressure data as is known on binary systems where one or more components are a hydrocarbon. From the data thus available, it is often possible to eliminate the investigation of many systems when searching for a suitable entrainer.

The object of this paper is to gather the data on azeotropes involving a hydrocarbon and tabulate them in a form most convenient for investigators in the hydrocarbon field.

Consider, for example, the separation of benzene from similar boiling paraffinic and naphthenic hydrocarbons. While no data are available on the azeotropes of paraffins boiling close to 80°C., it is safe to assume that any compound which forms an azeotrope with cyclohexane will also form an azeotrope with similar boiling paraffins. Scrutiny of the data reveals that methanol, ethyl acetate, ethanol, or methyl ethyl ketone would act as non-selective entrainers to effect the separation of benzene. By non-selective, we mean an entrainer that forms azeotropes with all the compounds of the mixture and separation must be made by means of the difference in boiling points between the azeotropes. A selective entrainer is one that forms azeotropes with only certain constituents of the mixture, and the separation is thus effected by means of the difference in boiling points between the azeotropes and the unaffected component. The data indicate that acetone and butyl nitrite will be selective entrainers for this separation.

Tables of Azeotropic data

The following tables contain the azeotropic data reported in the literature for binary systems where one or both of the components are hydrocarbons. For convenience, the hydrocarbons are listed according to class and boiling point. The various compounds tested with different hydrocarbons are listed by their boiling points only.

The hydrocarbons are divided into the following types: paraffin, naphthene, olefin, cyclic olefin, and aromatic. An additional section contains data for systems where both constituents are hydrocarbons. Here again the data are listed according to type and boiling point.

Listed above each table of data are the name and the boiling point of the pure hydrocarbon used with the listed compounds (entrainers). The first column gives the name of the entrainer and the second column lists the boiling point of the pure entrainer. Column three is the boiling point of the azeotrope. Where actual temperatures are not available, but where a minimum boiling mixture is reported, the word "Min." is given. If no azeotrope is formed, the word "No" is shown. The fourth column is the composition of the azeotropic mixture expressed in weight per cent of hydrocarbon. Column five gives the literature reference number from which the data were obtained. All temperatures are in degrees Centigrade at 760 mm. of Hg., and all compositions are at 760 mm. of Hg., unless otherwise specified.

The data for two-hydrocarbon azeotropes are similarly arranged. Columns one and two are the name and boiling point (°C. at 760 mm.) of the first hydrocarbon, and columns three and four are the name and boiling point of the second hydrocarbon. The azeotropic temperature is in column five and the composition of the azeotrope, expressed in weight per cent of the first hydrocarbon, is given in the sixth column. The last column gives the literature reference number.

*Presented at American Chemical Society Meeting, Cleveland, April, 1944.

†National Defense Research Committee, Washington, D. C.

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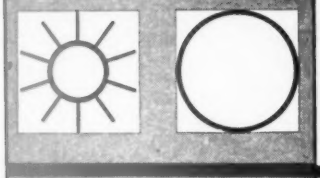
10 Superior Features of the G-FIN TANK HEATER

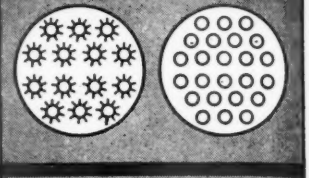


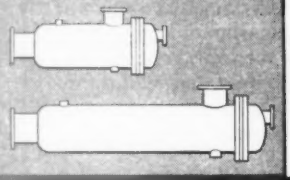
GREATEST HEATING EFFECTIVENESS . . .

The longitudinal G-Fins, extending from the outside surface of the pipes into the surrounding oil, give five times more heating contact than a bare tube occupying the same cross-sectional area.

FEWER TUBE JOINTS . . .

The small number of elements in a G-Fin Storage Tank Oil Heater results in a minimum of tube joints.



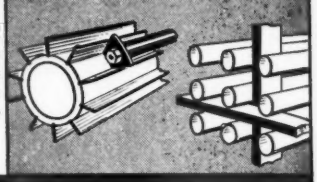


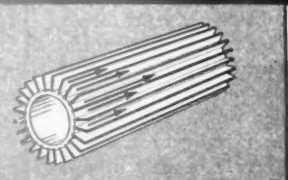
MOST COMPACT UNIT . . .

The increased heat transfer surface provided by the G-Fins in a given diameter of heater permits fewer tubes and a shorter shell requiring least space for a required duty.

ACCESSIBLE FOR COMPLETE CLEANING

Since the G-Fin Storage Tank Oil Heater has fewest tubes for a required duty, and all tubes are accessible for cleaning throughout their entire length and diameter, the cleaning time is considerably shortened.





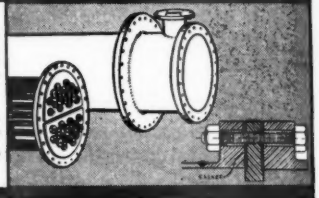
LEAST PRESSURE DROP . . .

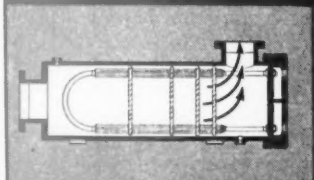
The straight-through flow of the oil passing through the heater results in a minimum pressure drop. The support plates for holding the heating elements in position are arranged so as to provide maximum free area for flow of oil.

EASILY EXAMINED AND CLEANED . . .

Threaded bolt holes in the tube sheet permit removing the cover for examination of the tube joints while the tank is full of oil.

After removal of the tube bundle from the shell, each U-bend element may be individually withdrawn for cleaning by backing off the lock-nuts at the tube sheet.



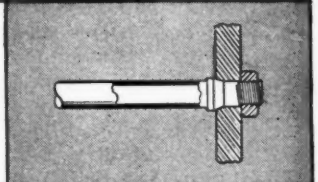


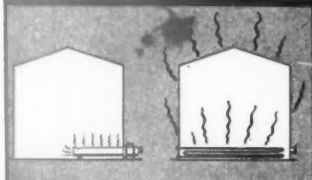
NO STRATIFICATION OR VAPOR BINDING

The oil outlet is located at the top of the shell so as to prevent a dead pocket which would result in stratified, stagnant accumulation of hot oil or vapor.

LEAKPROOF JOINTS . . .

The conical ends of the G-Fin heating elements are seated in the tube sheet with accurately machined metal-to-metal joints held tight by lock-nuts.



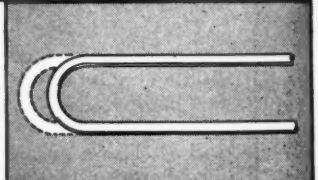


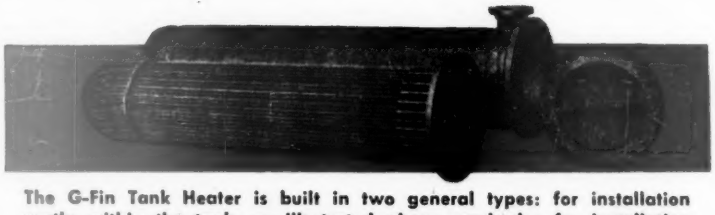
USES LESS STEAM . . .

By heating the oil locally at the point of withdrawal from the tank, the G-Fin Storage Tank Oil Heater uses less steam than would be required by pipe coils located along the bottom of the tank.

NO TEMPERATURE STRAINS . . .

The U-bend elements are free to expand and contract, so that there are no strains in the unit on change of temperature.





The G-Fin Tank Heater is built in two general types: for installation partly within the tank, as illustrated above, and also for installation outside the tank. The only difference between the two types is in the design of the shell at the floating end. Both types are built in a wide range of sizes.

This unit applies the many advantages of the well-known G-Fin heat transfer elements to the service of heating any viscous oil or other liquid in tanks.

Many thousands of G-Fin Tank Heaters are being used at refineries, tank farms, oil distributing centers, central power generating stations, chemical plants, gas plants, food processing plants, and industrial plants.

Write for Bulletin 1641 describing these units in detail.

THE GRISCOM-RUSSELL CO.

285 Madison Avenue NEW YORK 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

FLOW BEAN CAPACITY CHART

Barrels per day	Gallons per minute	Flow beam diameter required, inches	Stock size diameter, inches
25	0.729	0.05646	0.0625 — 1/16
50	1.457	0.0798	0.078125 — 5/64
75	2.186	0.09775	0.09375 — 3/32
100	2.915	0.1125	0.109375 — 7/64
125	3.646	0.1263	0.125 — 1/8
150	4.374	0.1383	
175	5.105	0.1494	
200	5.833	0.1596	0.15625 — 5/32
225	6.565	0.1694	
250	7.290	0.1785	
275	8.020	0.1871	0.1875 — 3/16
300	8.748	0.1954	
325	9.475	0.2034	
350	10.21	0.2112	
375	10.93	0.2184	0.21875 — 7/32
400	11.66	0.2256	
425	12.38	0.2327	
450	13.12	0.2394	
475	13.84	0.2460	
500	14.57	0.2523	
525	15.30	0.2586	
550	16.03	0.2646	
575	16.76	0.2706	
600	17.49	0.2764	
625	18.22	0.2822	0.28125 — 9/32
650	18.95	0.2877	
675	19.67	0.2930	
700	20.40	0.2984	
750	21.87	0.3097	
800	23.32	0.3193	0.3125 — 5/16
850	24.77	0.3291	
900	26.23	0.3387	
950	27.69	0.3480	
1000	29.15	0.3570	
1050	30.61	0.3660	
1100	32.07	0.3744	0.375 — 3/8
1150	33.53	0.3826	
1200	34.98	0.3910	
1250	36.44	0.3993	
1300	37.90	0.4070	
1350	39.36	0.4150	
1400	40.83	0.4226	
1450	42.27	0.4300	
1500	43.74	0.4377	0.4375 — 7/16
1550	45.20	0.4446	
1600	46.66	0.4514	
1650	48.12	0.4588	
1700	49.57	0.4659	
1750	51.05	0.4725	
1800	52.46	0.4786	
1850	53.93	0.4858	
1900	55.40	0.4925	
1950	56.85	0.4984	0.500 — 1/2
2000	58.33	0.5048	

NOTE: This table is for oil of 15° A.P.I. gravity to 45° A.P.I. gravity. The capacity varies as the square root of the pressure drop. Capacities shown are for 80-lb. pressure drop. Orifice contour constant "c" = 0.75.

$$q = ck\sqrt{2gh}$$

q = cubic ft. per sec.,
h = head in ft.,
c = orifice constant, and
k = area of orifice, sq. ft.

Table by courtesy of Kobe, Inc.

It's the Nash!

Nash Compressors in your plant can automatically increase the capacity of your absorption equipment, for with the Nash it is possible to secure absorption directly in the pump.

This is due to the Nash liquid compressant operating principle, involving a fluid vortex through which the gas must pass in the process of compression. To absorb from a gas, simply flow absorbent through the compressor as the compressing medium. In this close contact of liquid and gas, the desired fractions are picked up and retained by the absorbent. This in no way impairs efficiency as a compressor.

This useful stunt is made possible by the fact that slugs of liquid entering a Nash Compressor do no harm to the pump structure. Nash pumps have only one internal moving part, simple, non-wearing, and employ no gas contaminating internal lubrication. There are no valves, gears, pistons, or sliding vanes, and original pump efficiency is maintained over a long life. In a single stage Nash Compressors produce 75 lbs. pressure or vacuums to 26 in. of mercury, with capacities up to 6 million cubic feet per day in a single structure. Investigate these pumps now.

One moving part.

No internal wearing parts.

No valves, pistons, or sliding vanes.

No internal lubrication.

Low maintenance.

Slugs of liquid entering pump do no harm.

Original performance constant over a long pump life.

Non-pulsating pressure.

Saves floor space.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

303 WILSON, SO. NORWALK, CONN.

HYDROCARBON AZEOTROPES

PARAFFINS

ETHANE (—88.3°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Nitrous oxide	−89.5	Min.	..	4
Hydrochloric acid	−83.7	Min.	..	4
Carbon dioxide	−78.5	Min.	..	4
Sulphur dioxide (liq.)	−10.0	Min.	..	9
Methyl alcohol	64.8	..	..	4
Ethyl alcohol	78.3	..	..	4
Isopropyl alcohol	82.4	..	..	4
n-Propyl alcohol	97.3	..	..	4
Water	100.0	..	..	4
Butyl alcohol	117.7	..	..	4
Amyl alcohol	138	..	..	4

PROPANE (—42.2°C.)

Sulphur dioxide (liq.)	−10.0	Min.	78*	9
Methyl alcohol	64.8	Min.	..	4

*At pressure of 7 kg. per cm.² (Abt. 7 atm.)

ISOBUTANE (—12.4°C.)

Sulphur dioxide	−10.0	−24	..	10
Sulphur dioxide	−10.0	−27	..	13
Ethylene oxide	10.7	Min.	..	13
Methyl formate	31.5	Min.	..	13

n-BUTANE (—0.6°C.)

Anhydrous ammonia (liq.)	−33.4	Min.	..	12
Sulphur dioxide	−10.0	−18	..	10
Sulphur dioxide	−10.0	−22	..	13
Methylamine	−6.5	Min.	..	12
Methyl bromide	4.5	−4.4	45.8	26
Ethylene oxide	10.7	Min.	..	13
Methyl formate	31.5	Min.	..	13

ISOPENTANE (28.0°C.)

Sulphur dioxide	−10.0	Min.	..	13
Ethylene oxide	10.7	Min.	..	13
Ethyl chloride	13.3	12.0	5	1
Ethyl nitrite	17.4	16.5	15	1
Acetaldehyde	20.2	17	..	1
Methyl formate	31.9	17.0	53	1
Ethyl ether	34.6	No	..	1
Ethyl mercaptan	36.2	No	..	1
Isopropyl chloride	36.3	24	..	1
Ethyl bromide	38.4	23.5	70	1
Isopropyl nitrite	40.0	27.5	94	1
Methylal	42.2	27.0	77	1
Carbon disulphide	46.2	27.9	98	2
Carbon disulphide	46.2	No	..	1
Propyl nitrite	47.8	No	..	1
n-Propylamine	50.0	25.5	>80	1
Ethyl formate	54.1	26.5	82	1
Ethyl formate	54.1	No	..	1
Acetone	56.2	<26.0	>80	1
Methyl alcohol	64.7	24.5	96	1
Ethyl alcohol	78.3	26.8	96.5	2
Ethyl alcohol	78.3	No	..	1
Isopropyl alcohol	82.4	27.8	95	2
Formic acid	100.7	27.2	96	1
n-Butyric acid	163.5	No	..	1

n-PENTANE (36.2°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Sulphur dioxide	−10.0	Min.	..	13
Ethylene oxide	10.7	Min.	..	13
Ethyl chloride	13.3	No	..	1
Ethyl Nitrite	17.3	No	..	1
Acetaldehyde	20.2	No	..	1
Methyl formate	31.9	21.9	47	1
Ethyl ether	34.6	33.4	30	1
Ethyl mercaptan	36.2	32	50	1
Isopropyl bromide	36.3	32	48	1
Ethyl bromide	38.4	33	50	1
Methylpropyl ether	38.8	35.3	75	1
Isopropyl nitrite	40.0	34	60	1
Methylal	42.3	35.4	..	1
Methyl iodide	42.6	34	..	1
Carbon disulphide	46.2	35.7	90	2
n-Propyl nitrite	47.8	35.9	89	1
Ethyl formate	54.2	32.5	70	1
Diethylamine	56	35	85	1
Acetone	56.2	32	80	1
Acetone	56.2	No	..	1
Methyl acetate	57.0	No	..	1
Chloroform	61.2	No	..	1
Methyl alcohol	64.7	30.8	91	1
Isobutyl nitrite	67.1	No	..	1
Isobutylamine	68.5	No	..	1
Methyl borate	68.7	No	..	1
Ethyl alcohol	78.3	34.3	95	2
Isopropyl alcohol	82.4	35.5	94	2
n-Propyl alcohol	97.5	No	..	1
Formic acid	100.7	34.2	90	1
Nitrobenzene	210.9	No	..	1

n-HEXANE (69.0°C.)

Methyl formate	31.8	No	..	1
Ethyl ether	34.6	No	..	1
Isopropyl nitrite	40.0	No	..	1
Methylal	42.3	No	..	1
Carbon disulphide	46.3	No	..	1
Propyl nitrite	47.8	No	..	1
t-Butyl chloride	51.6	No	..	1
Ethyl formate	54.4	49.0	33	1
Acetone	56.2	49.8	41	2
Acetone	56.2	56	15	1
Methyl acetate	57.0	56.7	..	2
Methyl acetate	57.0	No	..	1
Chloromethylmethyl ether	59.5	58.8	10	1
Chloroform	61.2	59.9	28	1
Propylethyl ether	63.6	No	..	1
Methyl alcohol	64.7	50.6	72	2
Methyl borate	65	59	..	1
Isobutyl nitrite	67.1	65.0	44	1
Propyl mercaptan	67.5	<65	<45	1
Isobutylamine	68.5	61	50	1
Methyl borate	68.7	66.3	50	1
Isobutyl chloride	68.9	66.3	45	1
n-Propyl bromide	71	67.5	67	1
Ethyl iodide	72.2	68	24.5	3
t-Butyl bromide	73.5	68.7	..	1
Carbon tetrachloride	76.8	No	..	1
Ethyl acetate	77.2	66.0	58	1
Ethyl acetate	77.2	No	..	1
Butyl nitrite	77.8	68.0	82	1
Ethyl alcohol	78.3	56.7	79	2
Methylethyl ketone	79.0	64.2	63	2

(Continued)

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

You wouldn't put splints on a TOE DANCER

LAY·SET *Preformed* IS FREE

The preforming process frees LAY-SET Wire Rope of muscle-bound stresses. Being preformed, Hazard LAY-SET is not hampered by needless strains. Rather, every wire and strand is free to do its full share of work from the very first hour it is put on your machine.

Hazard LAY-SET Preformed is a "pre-broken-in" rope; it resists snarling and kinking; it handles easier, faster, safer and cheaper. It possesses high resistance to bending fatigue and so lasts longer—much longer than non-preformed wire rope. Regardless of where or how you use wire rope, whether for running or standing service, specify Hazard LAY-SET Preformed—the rope that gives you greater dollar value.

Hazard LAY-SET Preformed Wire Rope is "in the service", on countless jobs for the Armed Forces where it is proving its many advantages. Specify it for *your* use.

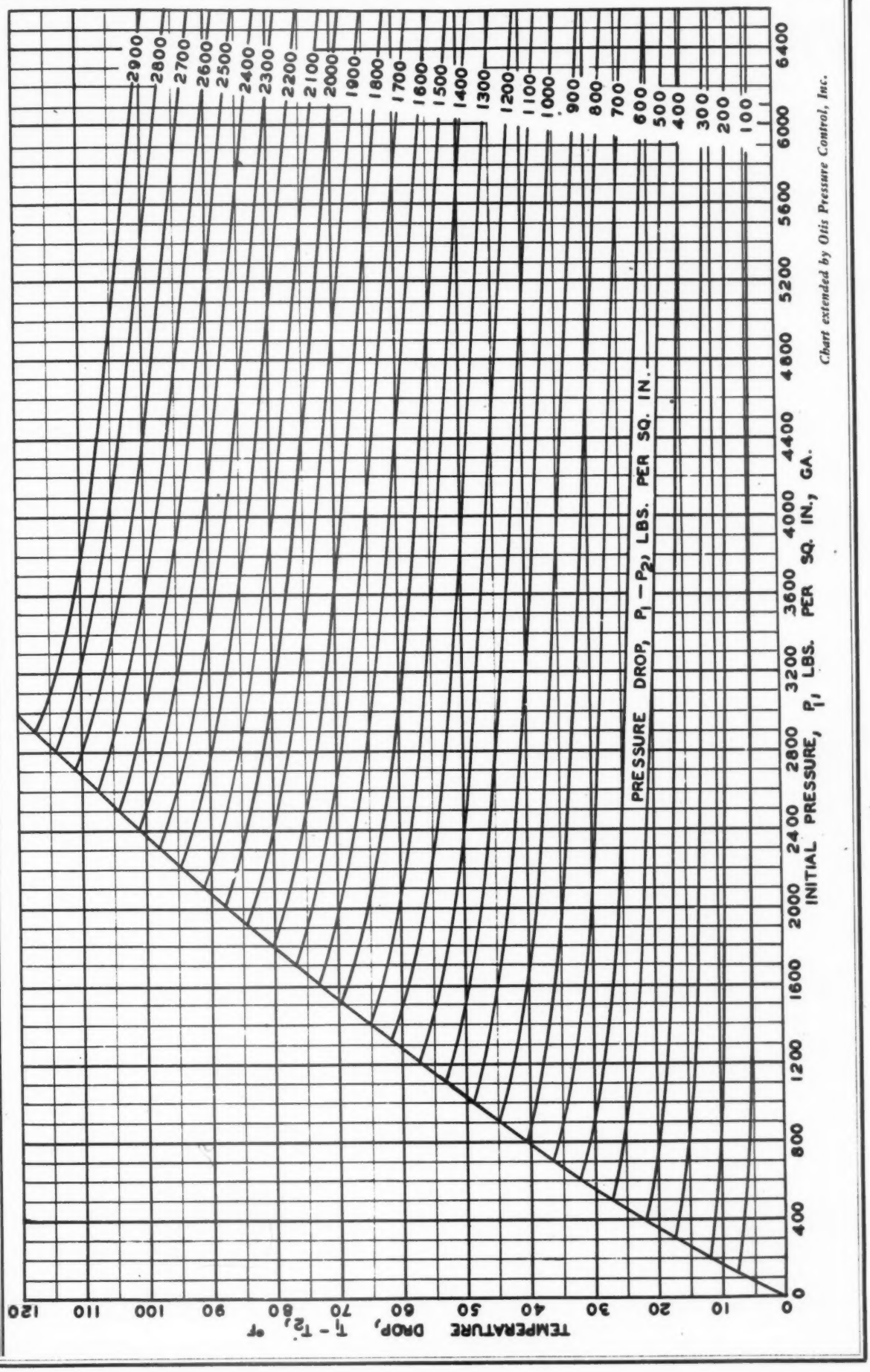
HAZARD WIRE ROPE DIVISION • Wilkes-Barre, Pa., Chicago, Pittsburgh, Fort Worth, Houston, Wichita, San Francisco, Denver, Los Angeles

Distributors in all important oil field centers

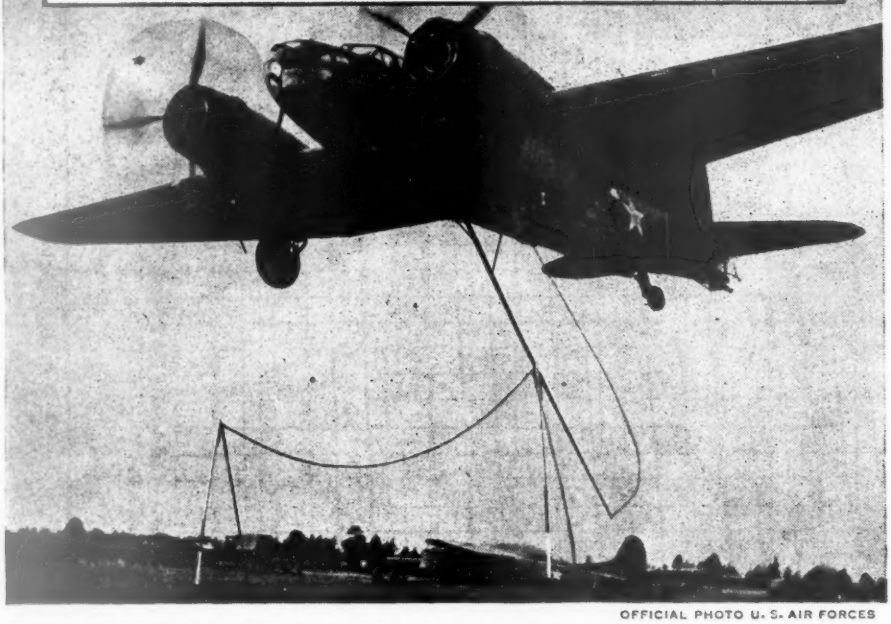
AMERICAN CHAIN & CABLE COMPANY, INC. • BRIDGEPORT, CONNECTICUT

HAZARD LAY·SET *Preformed* ROTARY LINES

TEMPERATURE EFFECTS OF THROTTLING GAS PRODUCED FROM DISTILLATE WELLS

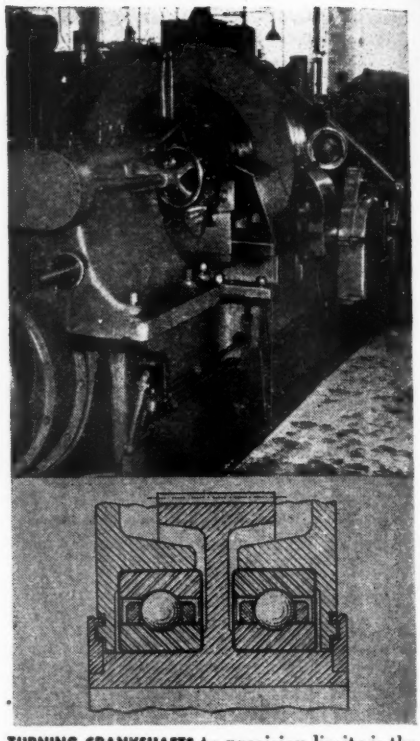


IN THE NEWS
WITH TORRINGTON BEARINGS

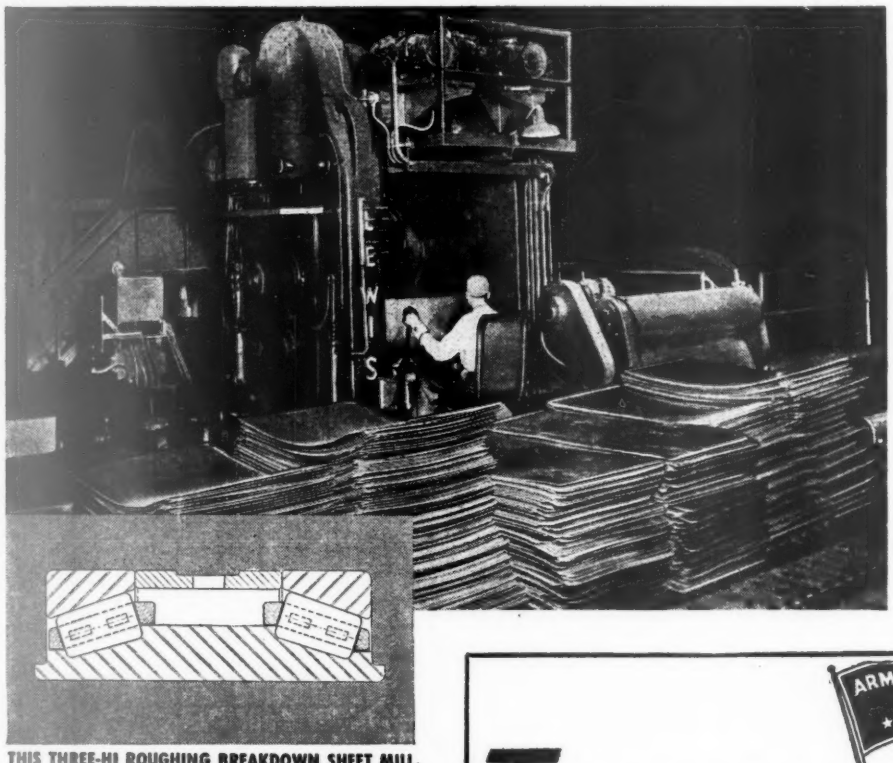


OFFICIAL PHOTO U. S. AIR FORCES

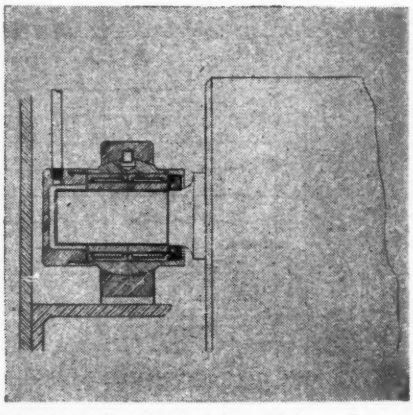
FLYING OVER 100 MILES AN HOUR this Army pilot of a Douglas B-23 tow plane is about to pick-up a 15-place glider. As the tow plane comes in, the arm of a pick-up device, manufactured by All American Aircraft, Inc., is lowered to catch the suspended tow line shown in the foreground. Torrington Ball Thrust Bearings were specified for installation in the mechanism of the pick-up, because of their capacity to withstand the severe and sudden shock loads encountered in the operation.



TURNING CRANKSHAFTS to precision limits is the important operation performed by this machine tool manufactured by the Hall Scott Motor Car Company. Due to high loads encountered in the center drive assembly, engineers specified the installation of two Torrington Ball Radial Bearings, as shown in the accompanying cross-section. The bearings have an outside diameter of 34"; an inside diameter of 27", and are 3½" wide.



THIS THREE-HI ROUGHING BREAKDOWN SHEET MILL, built by Lewis Foundry & Machine, is equipped with two-row tapered roller bearings, supplied by Torrington's Bantam Bearings Division, as shown in the accompanying cross-section. With each row employing 34 rollers, 1⅞" long and 1-3/32" in diameter, these bearings have a radial load capacity of 216,200 pounds; a thrust load capacity of 148,900 pounds at 100 R.P.M.



SUBMERGED in a bonderizing solution, the specially designed NCS Needle Bearings, shown in the accompanying cross-section, are sealed in a leak-tight housing equipped with a compressed air line to prevent the solution from reaching the bearing during operation. This is another example of Torrington's ability to adapt Needle Bearings to unusual applications. If you need counsel on standard or custom-built bearings, TURN TO TORRINGTON.

ARMY E NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

HYDROCARBON AZEOTROPES

PARAFFINS—Continued

n-HEXANE (Continued)
(69.0°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Methyl propionate	79.9	67	88	1
n-Propyl formate	80.9	63	80	1
Isopropyl alcohol	82.3	61	78	1
Isopropyl alcohol	82.3	65.7	96	2
t-Butyl alcohol	82.6	63.7	74.8	1
Dichloroethylene	83.7	No	..	1
Ethyl nitrate	87.7	67.0	82	1
Methyl carbonate	90.4	No	..	1
Isopropyl acetate	90.8	No	..	1
Methyl isobutyrate	92.5	No	..	1
Allyl alcohol	97.0	65.2	95.5	2
n-Propyl alcohol	97.2	65.7	95.7	3
Isoamyl nitrite	97.2	No	..	1
Isobutyl formate	98.2	68.5	88	1
Ethyl propionate	99.2	No	..	1
sec-Butyl alcohol	99.5	67.2	92	2
Formic acid	100.7	60.5	72	1
Formic acid	100.7	67	92	2
Propyl acetate	101.6	No	..	1
Dimethylethyl carbinol	101.8	68.3	96	2
Isobutyl alcohol	107.9	68.3	97.5	2
n-Butyl alcohol	116.9	No	..	1
Acetic acid	118.5	No	..	1
Amyl alcohol	138	No	..	4
Nitrobenzene	210.9	No	..	4

n-HEPTANE
(98.5°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Acetone	56.2	No	..	1
Methyl alcohol	64.8	59.1	48.5	2
Methyl alcohol	64.8	60.5	35.3	3
Ethyl acetate	77.2	No	..	1
Ethyl alcohol	78.3	70.9	51	2
Methylethyl ketone	79.6	77.0	30	1
Methyl propionate	79.9	No	..	1
Propyl formate	80.9	78.0	<30	1
Dichloroethylene	83.7	No	..	1
Trichloroethylene	86.9	No	..	1
Ethyl nitrate	87.7	82.5	32	1
Methyl carbonate	90.5	85.5	30	1
Isopropyl acetate	90.8	87.5	33	1
Isobutyl bromide	91.6	No	..	1
Methyl isobutyrate	92.5	89.5	30	1
Methylisopropyl ketone	95.4	90	50	1
Allyl alcohol	97.0	84.5	63	2
Isoamyl nitrite	97.2	94.5	45	1
n-Propyl alcohol	97.3	84.8	62	2
Isobutyl formate	97.9	92.0	50	1
Ethyl propionate	99.2	92.5	53	1
Formic acid	100.7	79.5	67	1
Propyl acetate	101.6	93.6	62	1
Diethyl ketone	102.2	93.5	65	1
Diethyl ketone	102.2	98.2	72	1
Methyl butyrate	102.7	94.9	66	1
Acetal	104.5	97.5	80	1
Pinacolin	106.2	<97	<85	1
Butyl formate	106.7	94.7	65	1
n-Butyl formate	106.9	90.7	60	1
Isobutyl alcohol	108	92.2	..	1
Ethyl isobutyrate	110.1	97.0	90	1
Methyl isovalerate	116.5	No	..	1
Isobutyl acetate	117.2	No	..	1
Acetic acid	118.5	91.9	67	2
Acetic acid	118.5	92.3	70	1
Ethyl borate	118.6	No	..	1
Ethyl butyrate	121.5	No	..	1
Isobutyl carbinol	131.3	97.7	93	2
Glycol	197.4	98.3	97	2

2, 5-DIMETHYLHEXANE
(109.2°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Methyl alcohol	64.8	61.0	40	2
Ethyl alcohol	78.3	73.6	41	2
Isopropyl alcohol	82.4	79.0	38	2
t-Butyl alcohol	82.6	81.5	23	2
Ethyl nitrate	87.7	86.0	18	1
Chloral	97.8	<97.0	>10	1
Propyl acetate	101.6	98.5	30	1
Diethyl ketone	102.2	98	40	1
Methyl butyrate	102.7	100.0	>25	1
Acetal	103.6	103.0	25	1
Chloropicrin	111.9	<108.0	>10	1
Stannic cloride	113.9	108.0	>48	1
Epichlorohydrin	116.5	107.0	75	1
Chloroacetone	119.7	<108.0	>65	1

n-OCTANE
(125.8°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Methyl alcohol	64.8	63.0	28	2
Ethyl alcohol	78.3	77	22	2
n-Propyl alcohol	97.2	95	22.7	3
Isoamyl nitrite	97.2	No	..	1
Formic acid	100.7	93.5	20	1
Propyl acetate	101.6	No	..	1
Methyl butyrate	102.7	No	..	1
Isobutyl alcohol	108	104	..	1
Epichlorohydrin	116.5	114.5	20	1
Isobutyl acetate	117.2	114.5	<30	1
Acetic acid	118.5	105.5	47.5	6
Chloroacetone	119.7	116.5	35	1
Ethyl butyrate	121.5	118.0	<40	1
Ethyl butyrate	121.5	No	..	1
Isobutyl ether	122.2	No	..	1
Propyl propionate	122.5	118.2	40	1
Isoamyl formate	123.6	<116.5	45	1
n-Butyl acetate	124.8	119.0	48	1
Mesityl oxide	129.5	123.0	70	1
Chloromethyl acetate	129.5	123.5	60	1
Chlorobenzene	131.8	No	..	1
Methyl lactate	143.8	<124.5	>80	1
Furfural	161.7	No	..	1
Acetamide	221.2	125.5	92	1

ISONONANE
(135.2°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Acetic acid	118.5	108.8	..	7

n-NONANE
(150.7°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Acetic acid	117.8	112.6	..	8

2, 7-DIMETHYLOCTANE
(160.2°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Formic acid	100.7	No	..	1
Acetic acid	118.5	No	..	1
Isobutyl carbinol	131.3	129.7	15	2
Propionic acid	140.9	138.3	30	1
Methylphenyl ether	153.9	No	..	1
Ethyl lactate	154.0	146.0	40	1
Isobutyric acid	154.4	147.6	45.0	3
Propyl isovalerate	155.5	<153.0	>30	1
Cyclohexanone	155.8	<153.0	>32	1
Bromobenzene	156.1	155.9	13	1
Chloracetal	157.4	155.5	35	1
Isoamyl propionate	160.3	155.0	50	1

(Continued)

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

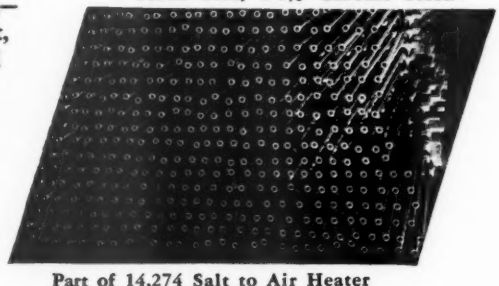
BROWN *Welded* FINTUBES

Sizes 1" to 8" in Diameter

● Conceived, perfected and available only from Brown Fintube, this welding of longitudinal U-shaped strip steel channels on the ***outside*** of the tube gives users the utmost in efficiency and performance. This construction avoids cutting grooves ***into,***—and any weakening of the center tube. It permits the use of any number of fins that can be spaced advantageously around the tube diameter . . . And since the wall thickness of the center tube is determined by pressure only—not depth of groove—thinner walled center tubes can be used, increasing the effectiveness of the heat transfer.

The integral—and permanent—metallic bonding between the fins and center tube avoids the presence of an air gap,—with its restriction to heat flow, and any cracks to collect dirt, and other insulating materials. Consequently Brown welded Fintubes have high transfering efficiency—***permanently maintained***—and trouble free operation during the life of the tube. Available with center tubes 1" to 8" diameter, fins ¼" to 1½" in depth, to produce primary to secondary surface areas in any ratio from 4:1 to 15:1. Tube and fins may be carbon or alloy steel. Tubes can be lined with copper, zinc, lead, aluminum or admiralty for handling corrosives. Specify Brown ***welded*** Fintubes for your requirements. Samples for experimental and small pilot plant purposes furnished free on request. Inquiries handled promptly.

A Few of the 236 Brown Fintubes used in 2 Toluene Plants. Tubes, 6" OD, ¾" Wall, 36' Long 9% Chrome Steel. Fins, 4-6% Chrome Steel.

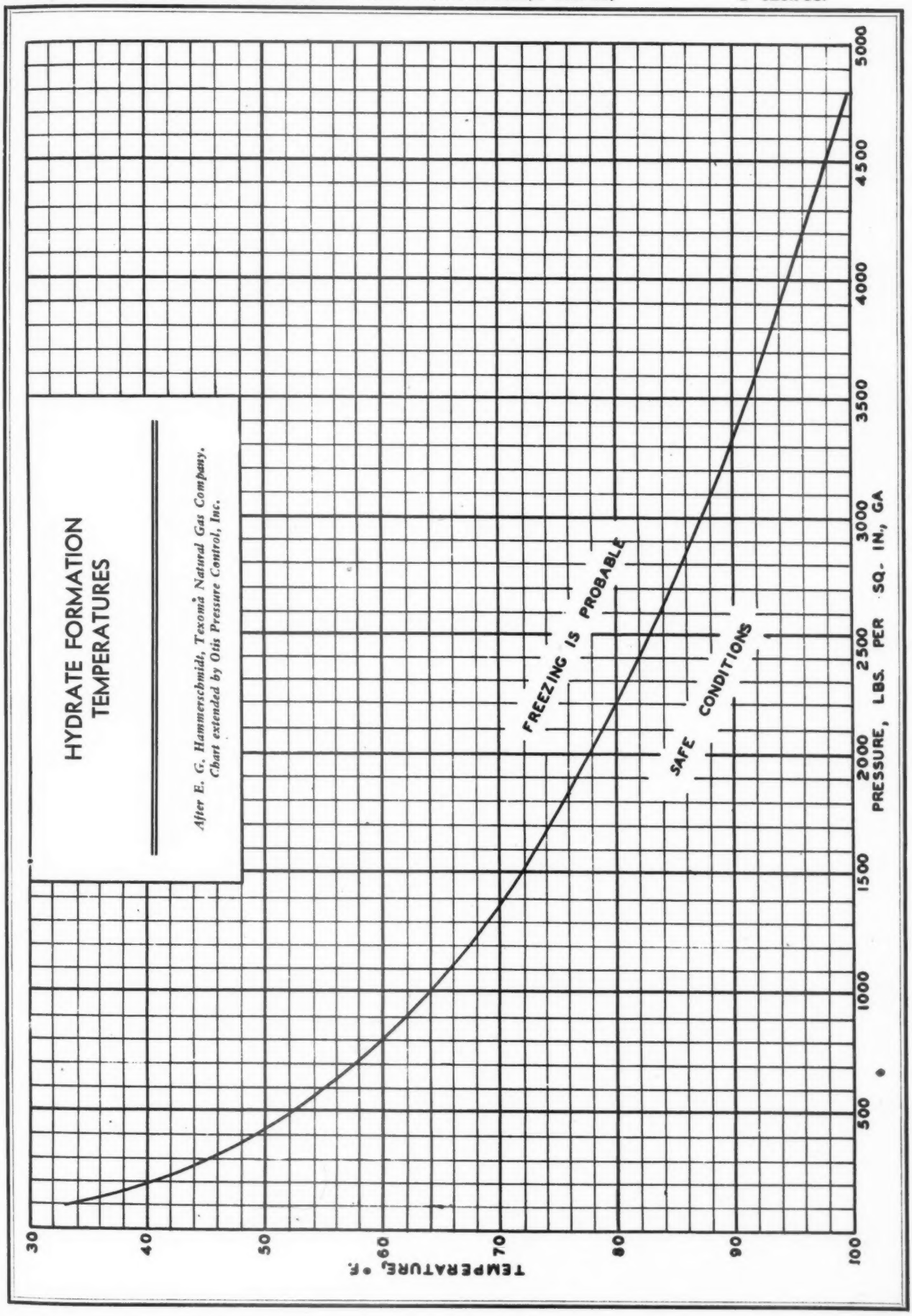


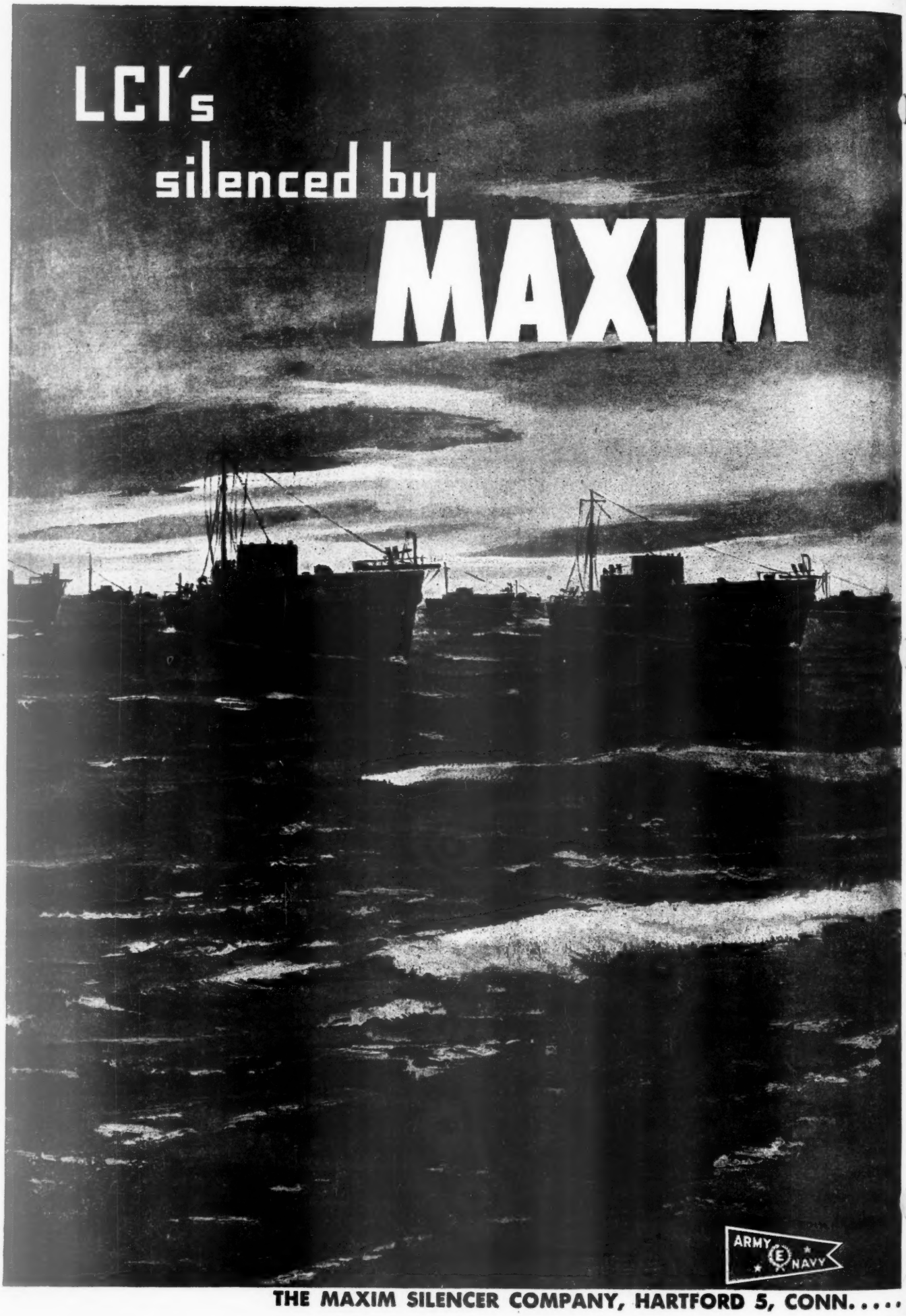
Part of 14,274 Salt to Air Heater Fintubes Awaiting Shipment. Tubes, 1" OD, 12 Gauge, 20' Long. Both Tubes and Fins Low Carbon Steel.

THE BROWN FINTUBE CO.

125 FILBERT STREET • ELYRIA, OHIO

MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS


HYDRATE FORMATION TEMPERATURES
After E. G. Hammerschmidt, Texoma Natural Gas Company.
Chart extended by Otis Pressure Control, Inc.
FREEZING IS PROBABLE
SAFE CONDITIONS
PRESSURE, LBS. PER SQ. IN., GA
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
TEMPERATURE, °F.
30
40
50
60
70
80
90
100



THE MAXIM SILENCER COMPANY, HARTFORD 5, CONN.....

HYDROCARBON AZEOTROPES

PARAFFINS—Continued

2, 7-DIMETHYLOCTANE (Continued)
(160.2°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Furfural	161.2	150.0	58	2
p-Chlorotoluene	161.3	158.5	50	1
n-Butyric acid	162.5	154.0	65	1
n-Butyric acid	162.5	155.8	70	1
Methyl oxalate	164.2	147.0	55	1
Isobutyl isovalerate	171.4	159.0	88	1
Isovaleric acid	176.5	158.0	82	1
Ethyl acetoacetate	180.4	159.0	..	1
Methyl malonate	181.5	<157	>70	1
Phenol	182.2	159.5	94	1
Phenol	182.2	No	..	1
Aniline	184.4	Min.	..	14

DECANE
(173.3°C.)

Name of entrainer	Boiling point of entrainer, °C.760 mm.	Azeotropic temperature, °C.760 mm.	Azeotropic composition, wt. % H.C.	Reference number
Methylheptanone	173.2	168.0	58	2
Aniline	184.4	Min.	..	14

n-TRIDECANE
(234°C.)

Pyrocatechol	245.9	229.7	70	1
Resorcinol	281.4	233.3	88	1

NAPHTHENES

CYCLOHEXANE
(80.8°C.)

Carbon disulphide	46.3	No	..	1
Acetone	56.2	53.1	32.7	5
Methyl acetate	57.0	No	..	1
Methyl alcohol	64.7	54.2	62.6	3
Isobutyl nitrite	67.1	No	..	1
Methyl borate	68.7	No	..	1
Isobutyl chloride	68.9	No	..	1
Carbon tetrachloride	76.8	76.5	..	1
Ethyl acetate	77.2	72.8	46	1
Butyl nitrite	77.8	75.5	40	1
Ethyl alcohol	78.3	64.9	69.6	3
Methyl propionate	79.6	74	45	1
Methylethyl ketone	79.6	72	60	2
n-Propyl formate	80.9	75	52	1
Isopropyl alcohol	82.5	68.6	67	1
t-Butyl alcohol	82.6	71.8	63.1	3
Ethylene chloride	83.0	75	..	25
Dichloroethane	83.7	No	..	1
Trichloroethylene	86.9	No	..	1
Ethyl nitrate	87.7	74.5	62	1
Methyl carbonate	90.5	78	80	1
Propyl ether	90.6	No	..	1
Isopropyl acetate	90.8	78.9	75	1
Methyl isobutyrate	92.3	78.6	88	1
Methylisopropyl ketone	95.4	79.0	<88	1
Chloral hydrate	96	76	77.4	3
Propylene chloride	96.8	..	84	25
Allyl alcohol	97.0	74	80.0	3
n-Propyl alcohol	97.2	74.3	76.4	3
Isoamyl nitrite	97.2	No	..	1
Isobutyl formate	98.2	80	>80	1
Ethyl propionate	99.2	No	..	1
sec-Butyl alcohol	99.6	76	..	1
Formic acid	100.7	70.7	70	1
Propyl acetate	101.6	No	..	1
Dimethylethyl carbinol	101.7	78.5	85	2
Diethyl ketone	102.2	No	..	1
Pinacolin	106.2	No	..	1
Isobutyl alcohol	107.9	78.1	86.0	3
Diethyl carbinol	116.0	80.0	97	2
n-Butyl alcohol	117.8	79.8	90.3	3
Acetic acid	118.5	79.7	98	1

METHYLCYCLOHEXANE
(101.1°C.)

Methyl alcohol	64.8	60	19	2
Methyl alcohol	64.8	60	30	1
Ethyl acetate	77.2	No	..	1

METHYLCYCLOHEXANE (Continued)
(101.1°C.)

Ethyl alcohol	78.3	73	30	2
Ethyl alcohol	78.3	73	47	1
Methylethyl ketone	79.6	78.0	30	1
Methyl propionate	79.6	No	..	1
Ethyl nitrate	87.7	83.9	28	1
Isopropyl acetate	90.8	89.0	22	1
Methyl isobutyrate	92.5	91.0	25	1
Allyl alcohol	97.0	85.0	58	2
Isoamyl nitrite	97.2	95.5	18	1
n-Propyl alcohol	97.3	86.0	58.5	2
Isobutyl formate	97.9	92.4	43	1
Ethyl propionate	99.2	94.5	47	1
Formic acid	100.8	80.2	53.5	1
Nitromethane	101.2	<99	..	1
n-Propyl acetate	101.6	95.5	52	1
Methylpropyl ketone	101.7	100.6	59.7	3
Allyl iodide	102.0	99.0	30	1
Diethyl ketone	102.2	95.0	60	2
Diethyl ketone	102.2	100.5	60	1
Propyl iodide	102.4	99.5	>20	1
Methyl butyrate	102.7	97.0	55	1
Pinacolin	106.2	98	70	1
Ethyl isobutyrate	110.1	100.0	>80	1
Chloropicrin	111.9	100.7	71	2
Stannic chloride	113.9	No	..	1
Acetic acid	118.5	96.3	69	1
Ethyl borate	118.6	No	..	1
Ethyl butyrate	121.5	No	..	1
Isobutyl carbinol	131.3	100.0	94	2
Glycol	197.4	100.8	96	2

1, 3-DIMETHYLCYCLOHEXANE
(120.5°C.)

n-Propyl alcohol	97.2	<94.0	<30	2
Chloroacetone	119.0	117.5	..	1
Isoamyl bromide	120.2	117.0	40	1
Tetrachloroethylene	120.8	118.0	..	1

ETHYLCYCLOHEXANE
(131.8°C.)

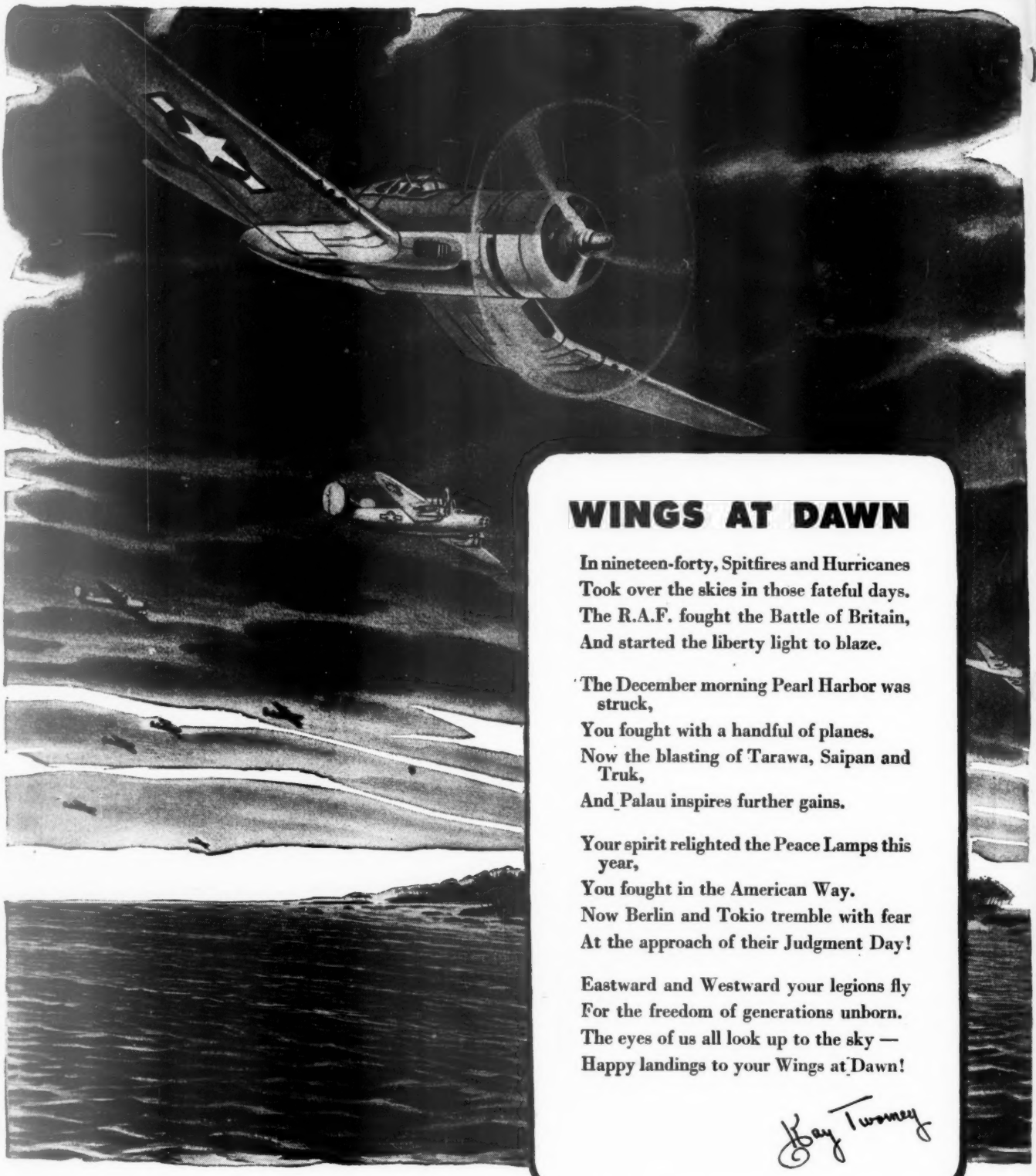
Acetic acid	118.5	107.9	..	7

NONANAPHTHENE
(136.7°C.)

Acetic acid	118.5	109.6	..	7

Literature references and explanation of azeotropic data are on sheet 1—P 721.9.

A TRIBUTE TO THE *Air Force* BY THE MAKERS OF TRI-SURE CLOSURES



WINGS AT DAWN

In nineteen-forty, Spitfires and Hurricanes
Took over the skies in those fateful days.
The R.A.F. fought the Battle of Britain,
And started the liberty light to blaze.

The December morning Pearl Harbor was struck,
You fought with a handful of planes.
Now the blasting of Tarawa, Saipan and Truk,
And Palau inspires further gains.

Your spirit relighted the Peace Lamps this year,
You fought in the American Way.
Now Berlin and Tokio tremble with fear
At the approach of their Judgment Day!

Eastward and Westward your legions fly
For the freedom of generations unborn.
The eyes of us all look up to the sky —
Happy landings to your Wings at Dawn!

Kay Twomey

Tri-Sure
Reg. U.S. Pat. Off.
CLOSURES

America's preeminence in the air has been won by the valiance of men, the power of planes — and the excellence of American fuel. The protection of that fuel — an ingredient of victory — is the war service of Tri-Sure Closures. When you see Tri-Sure Closures on a drumhead, you know that every drop inside is safe from seepage, leakage and contamination.

AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA

Running Tour WITH MEN IN THE INDUSTRY

▼ **Colonel R. W. McClenahan** of Philadelphia, on leave of absence from American Meter Company, now attached to the staff of Major General Elwood R. Quesada of the Ninth Air Force Fighter Command, has been awarded the Order of the British Empire by King George of England for distinguished service in cementing relations between the Allied nations. He was present at the Cairo and Teheran conferences where he served as an intelligence officer. At the conclusion of active war in the Arabian area, he was transferred to the European theater with the Ninth Air Force, which has played so large a part in the Normandy invasion and in the subsequent offensive battles of the Allied Armies. He has previously been awarded the Legion of Merit.

Col. R. W. McClenahan

▼ **Robert Brinton Harper,** vice president of the People's Gas Light and Coke Company of Chicago, is the 1944 recipient of the Honor Scroll award presented each year by the American Institute of Chemists to an outstanding member of the chemical profession. The award was made in recognition of Harper's distinguished service to the gas and allied industries as an organizer, executive, and scientist.

▼ **B. Brewster Jennings** of New York, new president of Socony-Vacuum, has been appointed to membership in the Petroleum Industry War Council, according to Harold L. Ickes. He fills the vacancy caused by the recent death of John A. Brown.

▼ **James H. Hershey,** 56, president of the Crown Petroleum Corporation, Wichita, Kansas, died September 23 as a result of injuries received when his car overturned. He was alone at the time of the accident.

▼ **C. W. Luton,** vice president and manager of Valvoline Oil Company, which was recently acquired by Freedom Oil Company, retired September 15. **Harry W. Johnson** will become refinery bulk sales manager; **Harold J. Dunmire** was named plant manager, and **J. J. Dunlevy** will be pipe line manager.

▼ **Shapleigh G. Gray,** for 11 years geologist with the Tide Water Associated Oil Company, in charge of the Louisiana-Mississippi districts, resigned October 1 to become consulting petroleum geologist and engineer with offices in Houston, Texas.

▼ **R. L. Clifton** has been appointed manager of the production department of Carter Oil Company, according to O. C. Schorp, president. Clifton had been serving in the post in an acting capacity for six months. He has been with the company for 27 years. **M. A. (Mike) Wright,** former chief engineer, has been appointed assistant production manager. **Ralph E. Damp** has been confirmed as general production superintendent. Succeeding Wright as chief engineer is **Carl G. Herrington,** former division engineer and assistant division superintendent at Seminole, Oklahoma. **W. E. Leroux** has been appointed to the latter post.

▼ **Roy T. Durst,** formerly a field engineer in the East Texas division office of Humble Oil and Refining Company at Tyler, who is stationed at headquarters of the Army Air Forces Training Command, has been promoted from major to lieutenant colonel. His work is concerned with the construction and maintenance of buildings, runways, and other facilities at stations of the training command, which operates a nationwide system of flying and technical schools for the individual training of AAF air crews and ground personnel.

▼ **James B. Black** of San Francisco, California, has been elected a director of United States Steel Corporation, according to Irving S. Olds, chairman. He is president of Pacific Gas and Electric Company of San Francisco. He is a director and member of the executive committee of the Southern Pacific Company and of several other major organizations.

▼ **W. B. Haas,** auditor of Standard Oil Company of Indiana's manufacturing department, will retire January 1, 1945, because of ill health. He has been on leave since the middle of September. **J. W. Binhammer** will become auditor, and **R. M. Eberly** will succeed Binhammer. **S. J. Sieben** becomes an assistant auditor in the manufacturing department.

▼ **Merle Blakely** had been added to the public relations staff of The Carter Oil Company. For the past five years he has been assistant director of public affairs of the Public Service Company of Oklahoma. Previous to that time, he was a newspaperman.

▼ **Wilbur F. Burt,** chairman of the manufacturing committee of the Socony-Vacuum Company since 1935, has been elected a vice president and member of the executive committee of the organization. He went to work in the crude stills of the Greenpoint Refinery of Standard Oil Company in 1912 upon his graduation from Amherst. By 1917 when he left to join the army he was assistant superintendent of the Queens County, New York refinery. Two years later on his return from service overseas, he became superintendent of the Pratt refinery in Brooklyn. In 1922 he was made general superintendent of the paint and cooperage department, and in 1925 was made manager of the company's claims and safety department. Two years later he was transferred to the manufacturing committee. He has been a director of the company since 1939.

Wilbur F. Burt

▼ **Daniel C. McCarthy** has been appointed to take charge of publicity for Socony-Vacuum. He will work under the direction of Burnham Carter of Ivy Lee and T. J. Ross, which firm handles public relations for the company. He was formerly assistant director of public relations for Firestone Tire and Rubber Company. He has been a reporter and was director of public relations for the National Tuberculosis Association.

▼ **Gordon Lefebvre,** president of Cooper-Bessemer Corporation, diesel engine manufacturers at Mt. Vernon, Ohio, and Grove City, Pennsylvania, has been elected to the executive committee of the Machinery and Allied Products Institute. Lefebvre was elected to fill one of five vacancies on the committee while 10 other members succeed themselves, according to the Institute's nominating committee. The executive committee to which Lefebvre has been appointed is made up of executives from the country's leading machinery builders.

Gordon Lefebvre

▼ **Howard E. Isham** has been appointed assistant vice president of United States Steel Corporation of Delaware, according to an announcement by M. D. Howell, vice president. Isham will continue as assistant treasurer of the Delaware corporation in addition to his new duties.

▼ **Lucien W. Moore,** formerly general purchasing agent of Crane Company, has been appointed manager of the valve and fitting sales department with headquarters at the Crane general offices in Chicago. Before his appointment, Moore had many years' experience in the sale of Crane valves, fittings, and pipes. He is succeeded as purchasing agent by **Thomas J. Hanlon** who has had wide experience as a buyer in the department.

▼ **E. O. Perkins** has been appointed general superintendent of the terminal division, refining department, of The Texas Company. He succeeds **J. E. Blake,** promoted to assistant general sales manager, foreign operations, for Texaco. Perkins entered the employ of the company in 1920 as a stenographer. He was superintendent of Texaco's Bayonne, New Jersey, terminal from 1933 to 1941 when he was appointed assistant general superintendent of the terminal division. Blake has been with the company since 1915 when he entered as an engineer at the Providence, Rhode Island, terminal. In 1928 he became superintendent of construction and terminals for Texaco in Europe, and in 1929 was made general manager of the company in Belgium. In 1929 he became managing director of that company, which position he held until the occupation of Belgium by the Germans. He was appointed general superintendent of the terminal division in August, 1941.

▼ **V. R. Oakley,** formerly general superintendent of Bareco Oil Company, has been elected vice president in charge of manufacturing, according to an announcement by O. L. Cordell, president. The promotion was voted at a meeting of the board of directors in September.

▼ **Joseph Naoum Toomi,** formerly superintendent of petroleum in the Iraq government, has been added to the Pawhuska research laboratory of the Skelly Oil Company. He is a native of Basrah, Iraq, but was educated at Hope College in Michigan and Ok-

lahoma A. and M. College in the United States. He has recently been employed by Douglas Aircraft of Tulsa, Oklahoma.

▼ **Leo D. Welch,** a vice president of the National City Bank of New York, has been elected treasurer of the Standard Oil Company of New Jersey, effective October 16. Welch, who has 25 years of experience in foreign banking, succeeds **J. E. Crane,** recently elected a director of the company. Crane will continue to supervise the company's financial operations as well as the comptroller and tax departments.

▼ **Earle W. Sinclair,** 70, retired president of the Sinclair Refining Company, died September 21 of a heart attack at the home of a friend in New York. Born in Wheeling, West Virginia, Sinclair became a banker at an early age and was elected president of the National Bank, Tulsa, Oklahoma, in 1913. He resigned the bank presidency in the early 1920's to become president of the Sinclair Consolidated Oil Corporation and its subsidiary, Sinclair Refining Company, organized in 1919 by his brother.

▼ **Alexander Boynton,** 61, of San Antonio, Texas, oil man who ran on the Republican ticket for governor in Texas in 1938, died September 21 of a heart attack in Philadelphia.

▼ **C. M. Mackey** has been appointed manager of the southwest district of Westinghouse Electric Supply Company according to D. M. Salsbury, general manager. Mackey joined Westinghouse in 1917 and since 1936 has been branch manager with headquarters in Houston, Texas. His new offices will be in Dallas.

▼ **Hugo L. Liebert, Fred S. Mackey,** and **Harry E. Ladwig** have been appointed general works manager of the tractor plants, general works manager of the machinery plants, and works manager of the West Allis foundries and pattern shops, respectively, of the Allis-Chalmers Manufacturing Company. All three men have been with the company for a number of years.

▼ **W. L. Scott,** manager of the light oil sales department of Talco Asphalt and Refining Division of Southport Petroleum Company, died in Dallas, Texas, on September 21. He had been in poor health for some time. He had a long record of service in the southwestern refining industry, having been associated at one time with American Refining Company, Wichita Falls, Texas, and other firms of that region.

▼ **Harold C. Olson** has been appointed sales manager and **John A. Toth** assistant

H. C. Olson

J. A. Toth

sales manager of the Torrington Company, Bantam Bearings Division, South Bend, Indiana. Olson has been with Torrington since 1935 serving formerly as district representative in Milwaukee and Pittsburgh and as assistant sales manager since 1941. Toth, with the company since 1929, has been special representative in the steel industry until his present appointment.

▼ **John Stumpf,** formerly with Hughes Oil Company, has joined Johnson Oil Refining Company as assistant sales manager. He succeeds **L. C. Denning,** who has been promoted to head Johnson's office at Des Moines, Iowa.

▼ **William Henry Davis** has been appointed as process engineer, engineering division, manufacturing department, Sun Oil Company, according to an announcement by Clarence H. Thayer, chief engineer. Davis formerly was eastern representative of Bechtel-McCone Corporation, Los Angeles, with headquarters in Philadelphia.

▼ **Charles G. Black,** 76, who served for 50 years with the Standard Oil Company as director and vice president, died in New York September 28. He is a former president of Standard Oil Company of New Jersey.

▼ **M. M. (Bud) Warden,** for eight years in the sales department of the Hughes Tool Company and for the past four as branch manager of Michigan, resigned September 30 to join the sales department of the Utility and Industrial Supply Company and the H. L. Gentry Engineering Company. His office will be in Jackson, Michigan.

▼ **J. S. Sawyer** has been appointed manager of the asphalt sales department of Shell Oil Company. He succeeds the late **David Waxman.** Sawyer is a member of the American Society of Testing Materials, the North Atlantic Highway Engineers, and the Asphalt Institute.

▼ **John S. Weller,** 78, president of Elk Petroleum Corporation and a member of the Arkansas Fuel Oil Company and Tropical Oil Company boards of directors, died in Pittsburgh, Pennsylvania, on September 26.

▼ **Joel C. Ott** has been promoted to district superintendent in charge of operations of the Humble Oil and Refining Company's Bayou des Glaise District, Louisiana Division.

▼ **William M. Schaill,** 64, for the past 18 years associated with Gulf Oil Corporation in New York, Colombia, and Venezuela, died September 15 in New York City. He was one of the original investigators of the Barco Concession, Colombia.

▼ **W. H. Newman** has been appointed as executive officer of PAW according to an announcement by Ralph K. Davies.

▼ **E. B. Wood,** Wyatt Metal and Boiler Works engineer, returned to Houston late in September from a three-month tour of Venezuela, Colombia, Trinidad, Curacao, and Mexico, where he investigated the possibilities of equipment to be used in new refinery construction programs. Wood is a member of the Houston chapter of Nomads.

▼ **Darrell W. Smith** has organized a new drilling contracting company under his own name with headquarters at Odessa, Texas. Smith has formerly been associated with Loffland Brothers and with Smith and Douglas Well Servicing Company. The new firm has 5 rotary rigs running at the present time in the Permian Basin.

▼ **A. C. Golden, Jr.,** has been appointed district superintendent by Pan American Production Company for its Southwest Louisiana district, with headquarters at Pine Prairie.

▼ **Wayne C. Edmister,** formerly with Rubber Reserve Company in Washington, D. C., is now connected with Foster Wheeler Corporation, Petroleum Division, New York City. Before joining the Rubber Reserve Company, Edmister was with Standard Oil Company of Indiana. Affiliation with Foster Wheeler was effective October 9.

▼ **W. R. Persons,** Pittsburgh District Manager of the Lincoln Electric Company, Cleveland, Ohio, has been transferred to the factory and main office at Cleveland to carry out a special postwar planning assignment. He has been with the Lincoln Electric Company since 1934, and became branch manager in 1937. **J. S. Roscoe,** former Syracuse

W. R. Persons

J. S. Roscoe

district manager for Lincoln Electric Company, has been appointed manager of the Pittsburgh office. He joined Lincoln in 1924 and became district manager at Syracuse the following year, continuing in that position until appointed to head the welding equipment company's activities in the Pittsburgh district.

▼ **John J. Farrell** has been appointed treasurer of the American Steel and Wire Company, Cleveland, Ohio, a U. S. Steel subsidiary. Formerly assistant treasurer of the company, he succeeds **Robert E. Lewis,** resigned. Only 38 years of age, Farrell began work in the New York offices of American Steel and Wire Company in 1922 as an office boy.

▼ **Karl W. Freeman** has been appointed southern district manager of International Harvester Company's motor truck division. He joined Harvester in 1925 and recently has been branch manager for the company at Atlanta, Georgia.

▼ **Frank C. Angle,** manager of Allis-Chalmers sales activities in the Pacific region, has been appointed manager of all Allis-Chalmers field sales offices of the general machinery division and their operations, according to an announcement by W. C. Johnson, vice president. He will continue his present duties, also. Angle was appointed manager of the Pacific region in 1942 and placed in charge of all Allis-Chalmers sales and engineering facilities serving industries in the Pacific Coast area. Prior to this he had been manager of the San Francisco district office.

▼ **Ernest L. Hughes,** District 2 director of distribution and marketing for PAW, has resigned his position to return to the Hughes Oil Company. It is probable that **Harry W. Nankervis,** now serving as manpower counsellor for PAW, will be appointed acting director succeeding Hughes.

▼ **Vernon W. Balzer,** assistant director of the Refining Division, District 5, PAW, has resigned to accept a position with Hallett Manufacturing Company, Los Angeles, as manager of its diesel division. Balzer was formerly with the Ford Instrument Company, Long Island City, New York, in a technical and executive capacity. During the early days of the war, he was asked to take charge of refining materials in Washington for PAW. He was transferred to Los Angeles in January, 1942, to set up the refining division in District 5 and remained as assistant director of the division.

Heavy Loads?
Heavy Pressures?
High Speeds?

PURPLE STRAND'S made for 'em

When they invented tough jobs in the oil industry, they handed one of the meanest of all to the rotary line.

In fact, when the hoisting drum starts winding in the rotary line with a mile or two of pipe on the hook, it's a chore that will simply break the heart of an ordinary rope. But the job's made to order for Purple Strand.

We say Purple Strand because, in a rotary-drilling rig, you need top-quality rope—rope that's made of improved plow steel in rotary-line construction; rope that supports terrific loads and resists the crushing imposed by overwrap.

But in specifying Purple Strand remember, too, that the rope should be Form-Set (Bethlehem's preformed). When it's a Form-Set rope . . . pliable, easy to spool . . . it combats the tremendous fatigue developed by winding onto a high-speed drum. This pays dividends in the form of longer life — fewer replacements — greater security.

Ask for Bethlehem's recommendations on rotary lines. Our engineers will be glad to work closely with you on problems involving this specialized part of your equipment.

When you think WIRE ROPE . . . think BETHLEHEM

BETHLEHEM STEEL

Tube Borium Keeps 'em digging

DULL IN 3 DAYS
STILL SHARP AFTER 30 DAYS
STOODY TUBE BORIUM* KEEPS DITCHER TEETH SHARP ...ELIMINATES FREQUENT SHUT-DOWNS FOR TOOTH CHANGES...CUTS REPLACEMENT COSTS UP TO 75%

The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.
The unprotected tooth at the top had to be sharpened every three days and was too short for further service after six sharpenings.
But the Borium-protected tooth at the bottom operated for 40 days and wore only ½". It was simply resharpened in the forge, retipped with Tube Borium, and put back on the ditcher for another 40 days' service.
Before the tooth was finally worn out, it had operated a total of 120 days!
Tube Borium makes such savings possible because the deposits represent the ultimate in wear resistance and the ability to cut hard earth formations.

*Stoody Tube Borium is supplied in rods of 1/8", 3/16", 1/4" and 3/8" diameters and is available for either oxyacetylene or D.C. electric application. Prices and specifications are yours for the asking.

These tungsten carbide particles do not melt when tube is applied but are held in suspension in a mild steel matrix forming a deposit resembling coarse sandpaper.

Send for free booklet on TUBE BORIUM, showing sizes and styles of rods and recommended methods of application.

STOODY COMPANY
1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear... Eliminate Repair

LAUGH WITH BARNEY

"Young man, I understand that you have made advances to my daughter."
"Yes, sir, I wasn't going to say anything about it, but now that you have, I wish you could get her to pay me back."

The new recruit was late for parade. "Well, it's so nice to see you, soldier," said the sergeant with a snarl. "We so feared you had signed a separate peace."

Visitor: Don't you cut yourself pretty often with this straight-edged razor?
Mountaineer: Naw, I been shaving nigh on to five years now and I ain't cut myself either time.

Clerk: Here's a pretty card with a lovely sentiment: "To the only girl I ever loved."
Sailor: That's fine. Give me a dozen.

She: When we get married I'm going to cook, sew, darn your socks, and lay out your pipe and slippers. What more can any man ask than that?
He: Nothing, unless he's evil-minded.

A comely young lady had entered the WACS and in bidding her farewell her friends reminded, "Be sure to write us often."
"I'll try," she replied, "but judging by my first few days' experience I'll be busy saying "Yes, sir," all day and "No, sir," all night.

How to cripple a wolf: Take his automobile away from him!

In the grammer lesson one day the teacher wrote on the blackboard:
"I didn't have no fun at the seaside."
Then she turned around to her pupils and said to one:
"Roland, how should I correct that?"
"Get a boy friend," he answered.

Sign in a roadhouse: "In case of an air raid, stand close to the slot machine. The jackpot has never been hit."

Lieutenant: How come your sergeant is laying there with his head bashed in?
Corporal: He advanced and I recognized.

A panhandler stopped a man on the street and asked for some money for something to eat. The man said, "I'll tell you what I'll do—I'll buy you a drink."
"I don't drink," said the panhandler. "All I want is some money for something to eat."
"I tell you what I'll do," said the man. "I'll get you a couple of real good stogies."
"I don't smoke," said the panhandler. "All I want is a little money for something to eat."
"I tell you what I'll do," said the man. "I've got a good tip on a little pony in the fifth this afternoon—it's going to win, 10-1. I'll put up the money, you take the winnings—how about it?"
"I don't gamble," said the panhandler. "All I want is a little money for something to eat."
"I tell you what I'll do," said the man. "I'll take you out to the house for dinner—I want my wife to meet you. I want her to see what happens to a man who doesn't smoke, drink or gamble!"

They say she used to be the belle of the town until somebody tolled on her.

In the early days of the railroads, a small road was famous for having a notoriously rough stretch of track. One day a new brakeman, making his first run, was standing in the center of the car, grimly clutching the seats to keep from being knocked over.
Suddenly the train struck a smooth piece of track and glided along with the greatest of ease, scarcely making a sound.
Seizing the lantern, the wildeyed brakeman ran for the exit. "Jump for your lives!" he shouted. "She's off the track!"

"Have you anything to say before I sentence you?"
"Only that I'm not guilty, and that I object to being identified by a fellow who had his head under the bed covers all the time I was in the room."

"I had to fire that new secretary."
"Didn't she have any experience?"
"No, not a bit. I told her to sit down and she looked around for a chair."

Jones: I didn't know you suffered from rheumatism.
Smith: Sure, what else can you do with it?

On a train a church dignitary was approached by a slightly inebriated young chap who invited him to join in a card game. The bishop quite naturally refused. And something in his manner may have been a tip-off, for his chance acquaintance asked:
"Shay, are you a preacher?"
"I am a Southern Methodist bishop."
"Southern Methodist? Gosh! Always thought that wash a football team!"

"If I had my time over again," counseled a meditative maiden lady of advanced years, "I'd get married before I had sense enough not to."

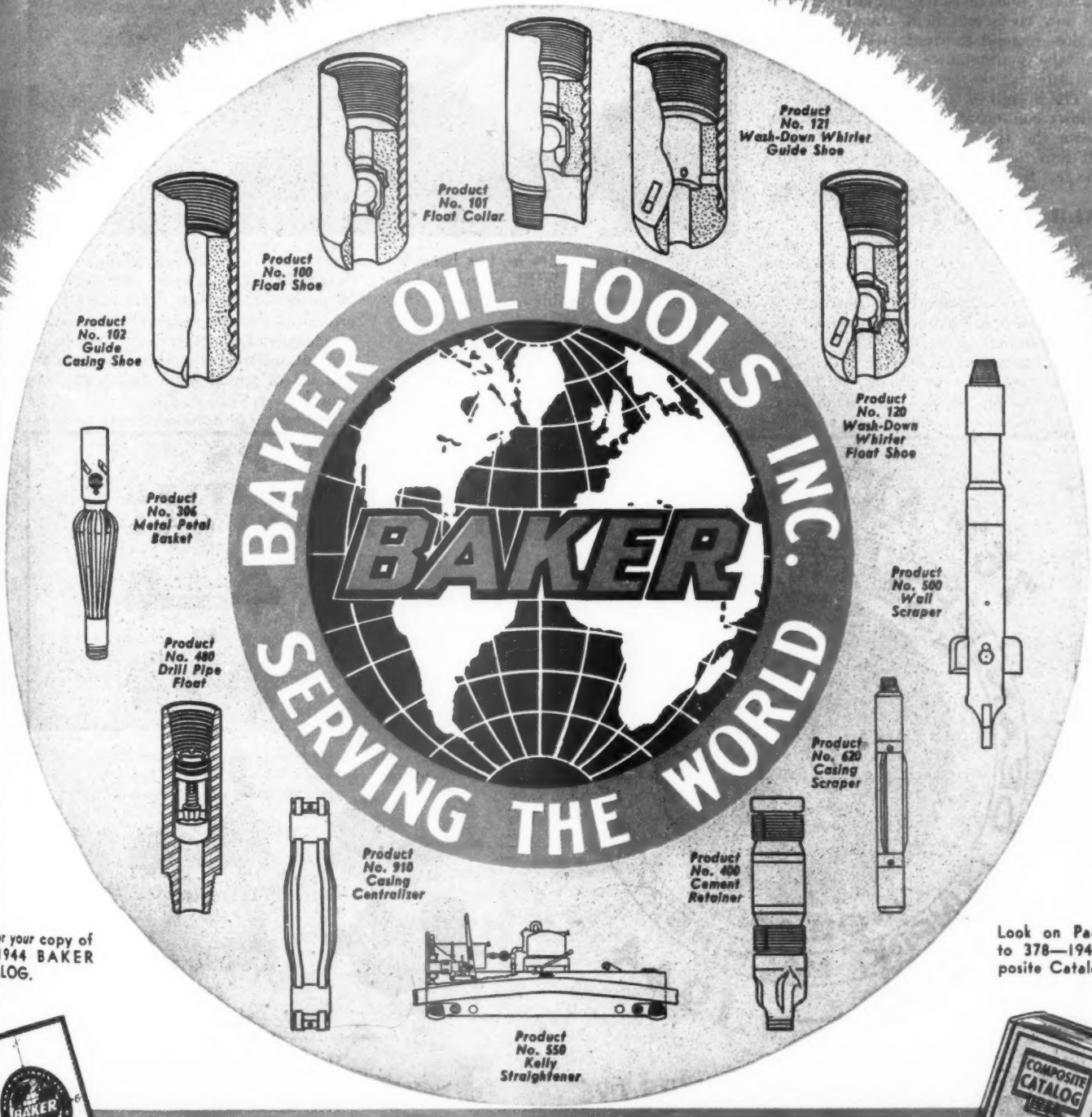
The boss discovered he had left his pocket knife at home. He tried to borrow one from his staff, but each man said he either did not have a knife or had failed to bring it to the office with him. It was finally Jimmy, the office boy, who supplied the missing article.
Admiringly the boss exclaimed, "How is it, Jimmy, that you alone out of the entire staff seem to have a pocket knife on you?"
"Dunno, Sir," was the matter-of-fact reply, "unless it's because my wages are so low I can't afford more'n one pair of pants."
He got a raise.

"Well, there's one thing to be said in radio's favor," began Morton.
"Really! What is it?"
"If you live in an apartment house you can tell what kind of neighbors you have by their sets."
"How come?"
"Easy. If they go for jazz, they are a peppy outfit; if they're fond of symphonies they're dead from the neck up; if they listen to political speeches they're nutty. But if they seldom turn the danged thing on, they're swell folks."

An old gentleman, some 75 years old, made this observation in a local grocery the other day: "I used to come in here, bringing my money in my pocketbook and carrying my groceries away in a basket.
"Now," he continued, "the process is reversed: I bring my money in a basket and carry my groceries in my pocketbook."

This is a very important time to be sure that any tools or equipment you use have been proved to be . . .

Practical & Dependable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for your copy of 1944 BAKER ALOG.

Look on Pages 3(to 378—1944 Con posite Catalog.

BAKER OIL TOOLS, INC.

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Plastics in lab equipment

The use of plastics in laboratory equipment is steadily increasing. The accompanying photograph shows the application of Styron (Dow polystyrene) for gable type covers on Serological Bath, designed for the U. S. Army Medical Corps for use in Wasserman and Kahn tests of blood samples at constant temperature of 37° C. and 56° C.

The improved cover was designed by the Precision Scientific Company, manufacturers of laboratory equipment and molded by the Elmer E. Mills Corporation.

Advantage of Styron in this application aside from its toughness, transparency and resistance to corrosion, is its low coefficient heat transfer, which makes a good thermal insulator allowing the maintenance of constant temperature inside the water bath.

The design of this plastic gable cover allows condensation of moisture to run down the side of the covers and drop off into the water bath instead of into the test tubes.

Ridley joins Foxboro

Walter H. Ridley has joined the sales promotion department of the Foxboro Company, makers of industrial instruments for measurement and control, with headquarters in Foxboro, Massachusetts. Since graduating from MIT in 1928, Ridley has been employed as designer and sales engineer for two different firms manufacturing textile mill machinery. For the past two years he has been in the Boston office of WPB, where he has worked with the problems of the textile industry.

L. R. Johnson dies

L. Ralph Johnson, vice president of Johnson Oil Refining Company, died at his home in Cleveland, Oklahoma, on September 24, of a heart attack. He was 58 years old, and had been active in the oil industry for 30 years. He was the last of a family of 4 brothers, all of whom had been at one time officials of the company and all of whom have died with heart trouble.

75TH ANNIVERSARY

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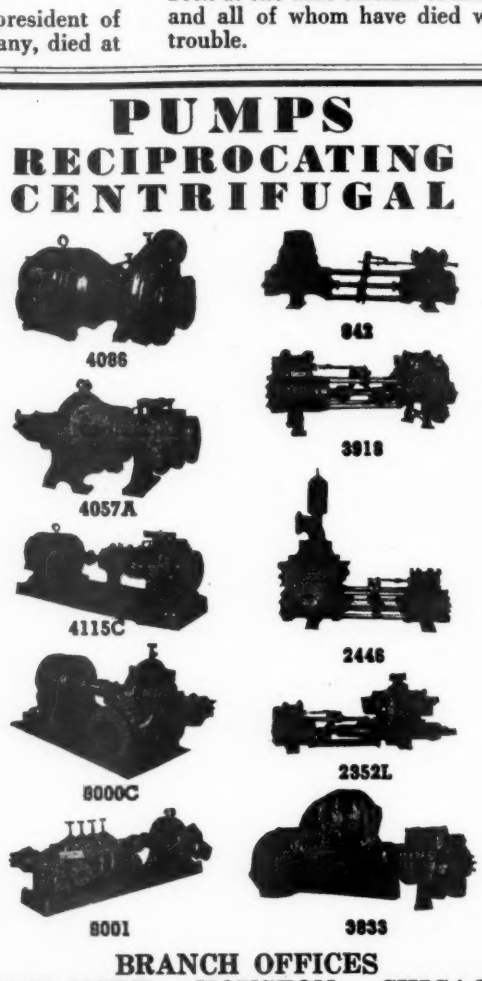


BRANCH OFFICES

NEW YORK HOUSTON CHICAGO

District sales manager

D. J. Ambrose has been appointed district sales manager of the Houston, Texas, office of Jones and Laughlin Steel Corporation effective October 1.

D. J. Ambrose

Ambrose has been assistant district sales manager of Jones and Laughlin's Cincinnati office since last February and except for one year at the Columbus office has been with J & L in Cincinnati for 23 years in various capacities. He succeeds Frank Winslow at Houston, who has resigned.

Howard Knobloch, who has been in the New York office since 1925, will be the new assistant district sales manager at Cincinnati.

U.O.P. given to A.C.S.

Ownership of the Universal Oil Products Company of Chicago, one of the leading research and development companies of the country, will pass to the American Chemical Society under the terms of a gift announced by Dr. Thomas Midgley, Jr., president of the society.

The value of the Universal Oil Products Company is estimated at from $10,000,000 to $15,000,000, Dr. Midgley said in addressing the members of the society at their annual dinner at the Waldorf-Astoria. The income, which will be used for research under the direction of the society, will be approximately $1,000,000 a year, according to Dr. Midgley.

"The owners of Universal Oil Products Company," Dr. Midgley stated, "have offered to give all the stock and securities of the company to the society. The board of directors of the society has accepted the offer in principle, and has appointed a special committee to complete the final details."

The Universal Oil Products Company is owned by 6 of the nation's largest oil companies: Phillips Petroleum Company, Shell Oil Company, Inc., Standard Oil Company of California, Standard Oil Company (Indiana), Standard Oil Company (New Jersey), and The Texas Company.

"When the gift is completed," Dr. Midgley continued, "the American Chemical Society will become 100 per cent owner of the Universal Oil Products Company. The gift is made with the provision that the entire income therefrom shall be used by the society at its discretion for research in the fields of science relating to the oil industry.

"Results of the research will be published and made available to the public without payment. The donors will have no rights to such results greater than those of the public at large.

"The society will use the income to foster public welfare and education, aiding the development of our country's industries, and adding to the material prosperity and happiness of our people.

"The owners of the Universal Oil Products Company have advised the American Chemical Society that they have assured the Universal organization that no plan will be adopted involving its dissolution nor will any action be taken that will affect the welfare of the company, which will continue with its research and development efforts and continue to render the same service to the refining industry, especially its licensees who number approximately 100. In other words, there is no intention to jeopardize the existence of the company nor the services it renders.

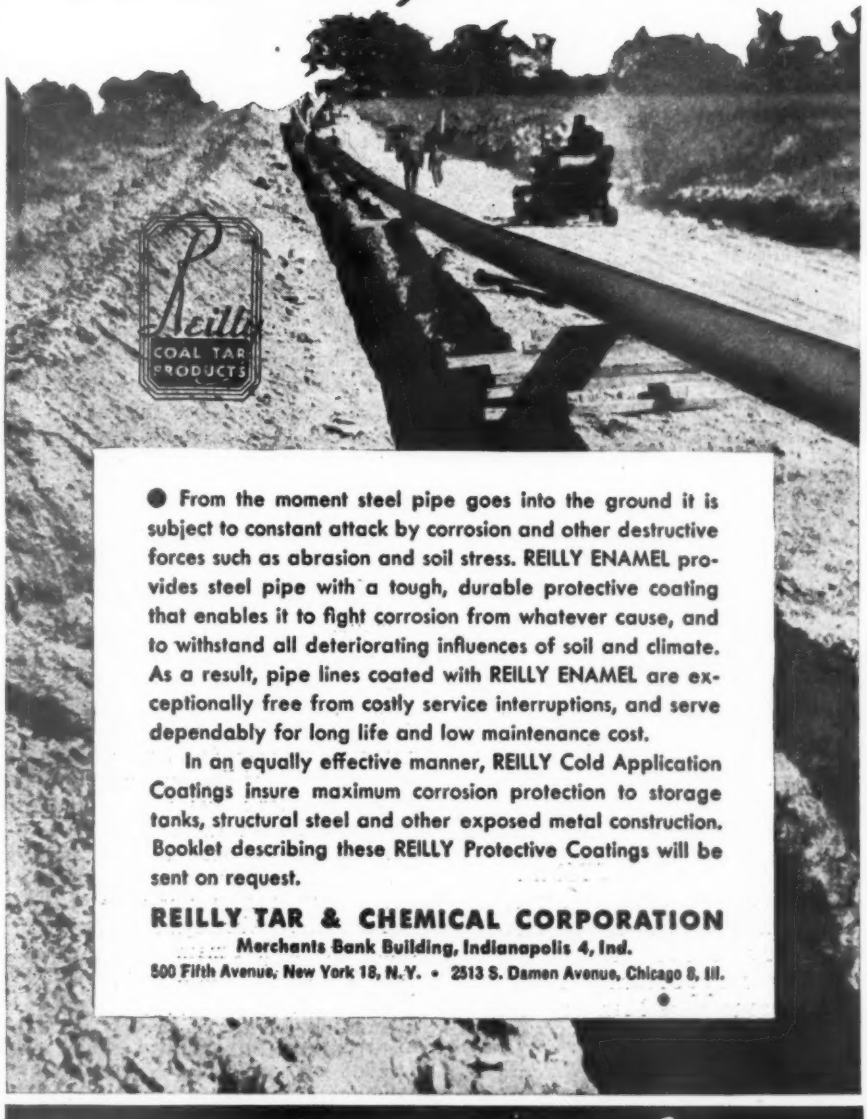
"The Universal Oil Products organization is presently devoting its entire efforts to a large part of the aviation gasoline program which comes under its jurisdiction and supervision. This program involves 6 basic processes developed by Universal of which there are approximately 75 installations in successful operation in the different refineries scattered throughout the nation."

C. A. Gutgesell dies

Charles A. Gutgesell, assistant vice president of The Continental Supply Company, Dallas, died August 28 in Laurel, Mississippi, of a heart attack. He had been with Continental for 21 years, having joined the company on February 16, 1923.

Corrosion-Proofed

WITH Reilly PIPE ENAMEL



● From the moment steel pipe goes into the ground it is subject to constant attack by corrosion and other destructive forces such as abrasion and soil stress. REILLY ENAMEL provides steel pipe with a tough, durable protective coating that enables it to fight corrosion from whatever cause, and to withstand all deteriorating influences of soil and climate. As a result, pipe lines coated with REILLY ENAMEL are exceptionally free from costly service interruptions, and serve dependably for long life and low maintenance cost.

In an equally effective manner, REILLY Cold Application Coatings insure maximum corrosion protection to storage tanks, structural steel and other exposed metal construction. Booklet describing these REILLY Protective Coatings will be sent on request.

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FOR METAL, STONE, BRICK, CONCRETE AND WOOD SURFACES

Divisional offices

Completing National Carbon Company's new sales set-up under which all company products are to be handled nationally from 7 divisional offices, new headquarters were opened on October 1 in New York, Pittsburgh, and Chicago. Similar offices were established a few months ago at Atlanta, Dallas, Kansas City, and San Francisco.

F. W. Berdan is manager of the New York division. He has been with the company since 1922 and has held executive positions since 1929, for the last several years in New York. Assistant division managers are G. A. Blackburn and A. B. Oatman. Blackburn became a salesman in the company's former carbon products division in 1936 and was appointed manager of the division's New York sales district in 1942. Oatman went with the company in 1916 and has had an executive sales position since 1939.

J. A. Hammond, who has been with National Carbon since 1923 as salesman and sales executive, will manage the Pittsburgh division. He became district manager of the former carbon products division at Chicago in 1930, and since early last year has served at Cleveland as assistant general sales manager of that division. F. S. Haggerson and W. E. Herr have been named assistant managers. Haggerson joined the sales staff of the former electrode division 7 years ago after 2 years in the company's electrode plant at Niagara Falls, New York. He became sales manager of the electrode division in the Pittsburgh district 2 years ago. Herr has been with the company as salesman and sales executive since 1922.

Heading the Chicago division is H. A. Stewart, who has been with the company since 1919. He has worked continuously in Chicago, first as a salesman and later as a sales executive. Assistant division managers are C. H. Christensen and W. L. Julian. Christensen began with National Carbon about 20 years ago and has put in much of his time as a sales representative in the carbon brush division. He was made district manager of the former carbon products division in St. Louis at the beginning of 1940, going to Pittsburgh as district manager in August, 1943. Julian began as a salesman 15 years ago in the brush department of the former carbon products division. He shifted to the former electrode division 7 years ago, with headquarters in Chicago.

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"Oilwell" News

The turbulent history of Oil Well Supply Company, is contained in the first edition of the company's new employe magazine, "Oilwell" News, published in Dallas, Texas.

National headquarters of "Oilwell," a subsidiary of U. S. Steel Corporation, is in Dallas.

Virginia Gulledge, Dallas, is editor-in-chief of the publication; R. F. Smalley, J. B. Creen, and Kenton Chickering, associate editors; Agnes Farmer, art editor.

"Oilwell" News is published by the employes of the company. The first edition is dedicated to the history of the people who made "Oilwell" history.

Plant editors include: M. A. Adhemar, Imperial Works; Stanley Burt, Oswego Plant; Edwin Paulie, Wilson-Snyder Division, and E. C. Flinner, Witte Engine Works Division.

Division editors are: C. J. Hill, California Division; J. S. Fuller, Midwest Division; C. H. Maynard, Eastern Division, and J. J. McAuliffe, Export Division.

Named electrical engineer

Worthington Pump and Machinery Corporation, Harrison, New Jersey, announces that C. W. Camp, formerly with Crocker-Wheeler Electric Manufacturing Company for 38 years, specializing application engineering, is now associated with Worthington as consulting electrical engineer.

A former executive member of the National Association of Electrical Manufacturers, Camp brings a wide background of experience in the electrical industry to his new work with Worthington's public utilities department.

Camp, who replaces the late Harry Wood, will assist in solving electrical application problems for all Worthington sales divisions and district offices. His services will also be utilized by the company's manufacturing departments.

W. A. Anderson dies

William A. Anderson, president of John A. Roebling's Sons Company, Inc., since 1936, died September 10 at his home in Princeton, New Jersey, in his 75th year. He had served the Roebling organization, manufacturers of wire and wire products, of Trenton and Roebling, New Jersey, for 56 years.

Widely known throughout his company and in the wire industry as "Big Bill," Mr. Anderson was the object of tribute from hundreds of office and mill workers alike. Although in ill health for some time, he had maintained daily contact with his office until just prior to his death.

Born in Trenton in 1870, he attended Lawrenceville Preparatory School and in 1888 began his long career with the Roebling organization by working as a timekeeper in the wire mills. Thereafter he progressed through various positions to that of superintendent of wire drawing operations.

On January 9, 1922, he was elected a member of the board of directors and the following year became general manager of the company. He assumed the additional duties of first vice president and treasurer in 1927, and in 1936 was elected president, succeeding the late Ferdinand W. Roebling, Jr.

Heads Socony-Vacuum

The board of directors of Socony-Vacuum Oil Company, Inc., has elected B. Brewster Jennings president of the company and chairman of the executive committee. Jennings succeeds the late John A. Brown.

Harold F. Sheets, vice president of the company, was elected chairman of the board, a position that has been vacant since 1935.

B. B. Jennings

H. F. Sheets

As chief executive officer, Jennings brings to the company 24 years' experience in several different departments of the business.

Sheets has been with the organization 37 years, of which 17 were spent abroad. He has been a vice president of Socony-Vacuum since 1932, in charge of the company's foreign trade.

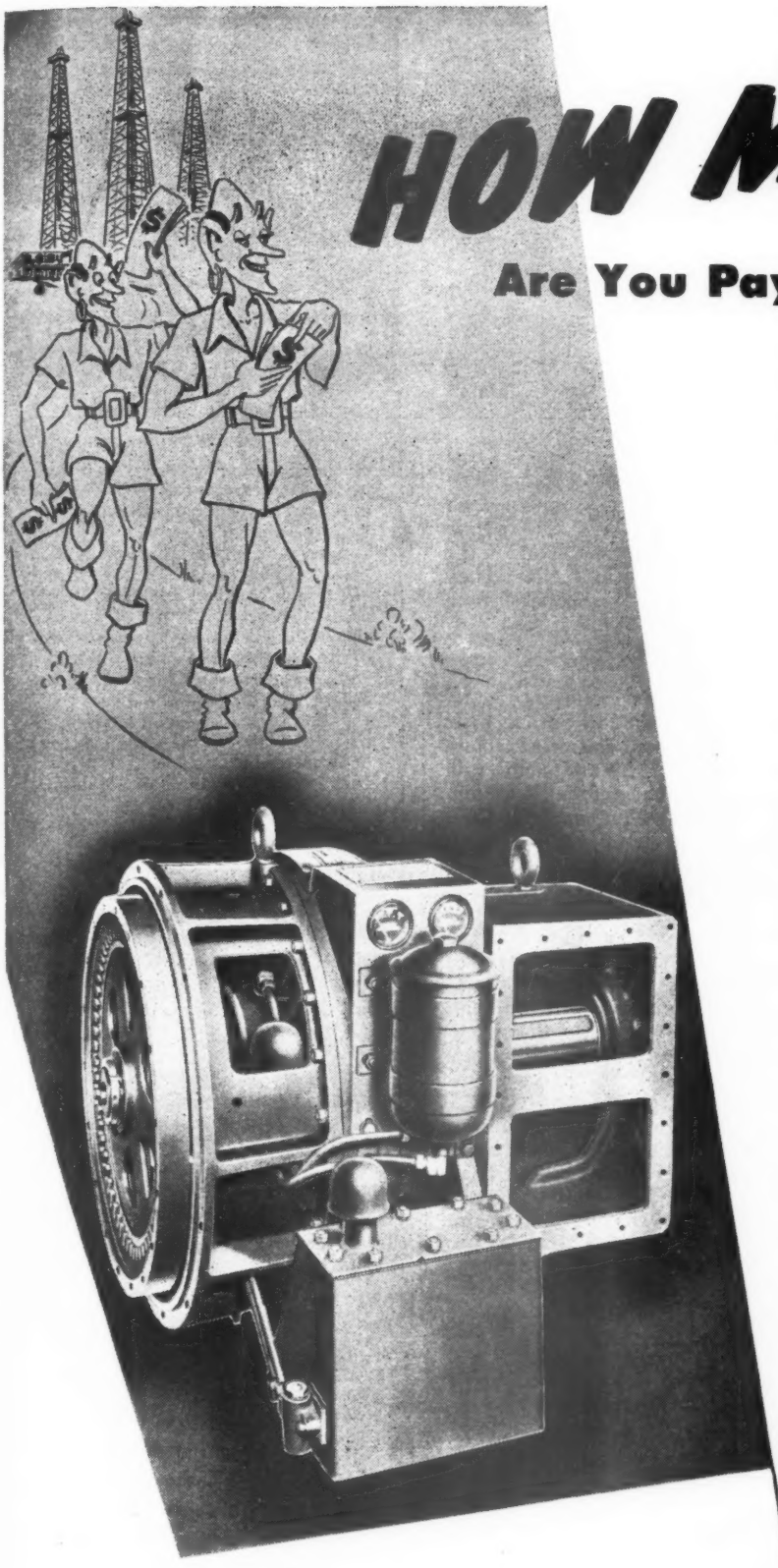
New distributors

Three new distributors for Bucyrus-Erie oil well spudders have been appointed to serve various territories, according to a recent announcement by Bucyrus-Erie Company, South Milwaukee, Wis.

Great Northern Tool and Supply Company, Billings, Montana, will be sales outlet for Bucyrus-Erie spudders in Wyoming and Montana, except the northwest corner of the state. The company also operates branches at Cut Bank and Kevin, Montana, and Casper, Wyo.

Randall-Zogg Supply Company, Owensboro, Kentucky, will handle the popular 24-L and 36-L spudders in the western half of Kentucky and a narrow strip of north central Tennessee, including the countries of Macon, Sumner, Robertson, Montgomery, and Stewart. Headquarters of the Randall-Zogg Supply Company are at 1420 Lewis Street in Owensboro.

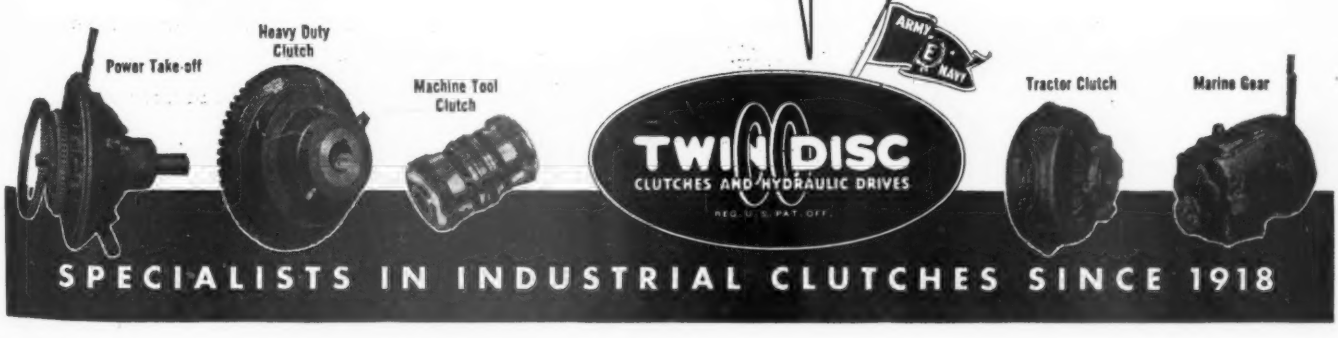
The Turner Valley Supply Company, Ltd., Calgary, Alberta, Canada, will distribute Bucyrus-Erie oil well drills in the Canadian provinces of Saskatchewan and Alberta, with branch at Black Diamond, Alberta.



HOW MUCH

Are You Paying the "Jerks"?

If you counted up the cost of the "jerks" —the snaps and shock loads to which your engine transmission, your wire ropes and cables are being submitted—even under ordinary working conditions, you might find that the cost of repairs and replacements would pay for a Twin Disc Torque Converter! Add to this the other "plus" advantages which the Converter gives; the protection to your engine . . . the smoothing out of cyclic variations . . . the added torque when you need it most, and you'll see why Twin Disc Torque Converters (Lysholm-Smith type) are gaining in recognition and preference among drillers who demand the utmost in modern drilling equipment . . . rigs in which the jerks, snaps, and shock loads are cushioned out with Twin Disc Torque Converters. Why not write for the new Torque Converter Bulletin No. 135A and get all the facts, or call on your nearest Twin Disc representative? TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).



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Division sales manager

The National Supply Company announces the appointment, effective October 1, of K. O. Hoevel as division sales manager, midwest division with headquarters at Tulsa, Oklahoma.

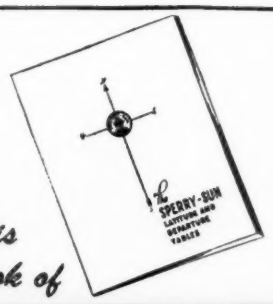
K. O. Hoevel

Hoevel entered the service of the National organization in 1933 as a storeman at Seminole, Oklahoma. In 1935 he was transferred to the Torrance, California, plant and later returned to the Kansas fields as field salesman and rotary serviceman. Later he was sales engineer at division headquarters in Tulsa and in 1941 was transferred to National's Toledo plant to serve in a supervisory capacity in the construction of propulsion gears for U. S. naval craft.

New Kellogg office

Oil refiners in the important Southwest and Gulf district now have at their service a new regional source of technical information, contact and counsel on the latest petroleum refining developments throughout the nation. The M. W. Kellogg Company, petroleum and chemical engineers, of Jersey City, New Jersey and New York, New York, announce the opening of a new office at Houston, Texas, which will specialize in keeping Gulf district refiners informed through close personal contact on significant trends and advances in the field, particularly with respect to the extensive postwar studies now being conducted by that company's engineering division.

Located in the Mellie Esperson Building at Houston, the new office is in charge of W. T. McCay, who has been associated with the oil refining industry in the Gulf area for a number of years.



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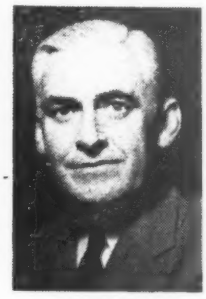
Research company changes

Frank A. Howard, president of the Standard Oil Development Company and original administrative head of the organization, has announced his resignation. R. P. Russell, executive vice president of the company since 1937, has been elected to succeed Howard.

F. A. Howard
Affiliated Photo-Conway



R. P. Russell
Vogel Studio

Howard will remain a director of the company and vice president of Standard Oil Company (New Jersey) until after the first of the year when he expects to resume private law practice from which he withdrew in 1919 to organize and manage the industrial research group which eventually became the Standard Oil Development Company. In private practice, he will serve the company as patent counsel.

The new president of the development company, Mr. Russell, has been with the company since 1927 when he left an assistant professorship of chemical engineering at Massachusetts Institute of Technology to direct the newly organized Esso Laboratories at Baton Rouge.

It is also announced that W. R. Carlisle had been elected a vice president of the development company. Carlisle left the New York law firm of Davis, Polk, Wardwell, Sunderland, and Kiendl to join the company in 1930. For many years he made his headquarters in London and was active in the organization of the Esso Laboratories there in 1937.

Opens Tulsa office

According to the announcement of P. P. Daniel, president, the Daniel Orifice Fitting Company has opened an office in Tulsa, Oklahoma. It will be under the management of F. N. Davis, formerly with Manning, Maxwell and Moore. Davis has had a diversified experience in engineering. The new office is located at 310 Thompson Building. Headquarters for the company are in Los Angeles, California.

Petroleum or Mechanical Engineer with several years field experience in well completion and production preferably in the Gulf Coast area to promote sales of technical oil field services and equipment. Permanent position with good future for man with imagination, initiative, and genuine interest in sales engineering. Give full details of education, experience, and availability in first letter. All replies held confidential. Box 18 % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

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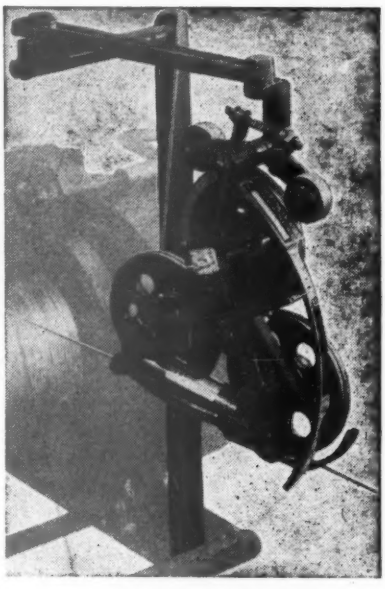

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Type B Measure Meter and Weight Indicator, pictured here, gives accurate measurements and eliminates the factor of human error, by indicating on easily read dials, the weight and length of lines in the hole.

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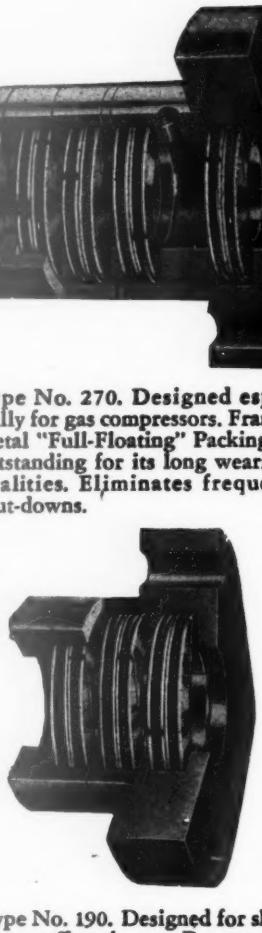

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Moves division offices

The California division sales offices of Kobe, Inc., manufacturers of hydraulic oil well pumping equipment and precision gauges, were moved on September 1 from the company's general offices on Slauson Avenue to a suite of offices in the Wilson Building, Huntington Park. The address of the new offices, which are in charge of W. F. Slater, division manager, is 217 Wilson Building and the telephone number remains the same, Kimball 1271.

W. F. Slater

This move is necessitated by the company's expanding business and it is believed will insure more prompt and effective service for California customers.

Acquire properties

C. R. Cox, president of National Tube Company, U. S. Steel Corporation subsidary, announces the acquisition of buildings and properties of Tubular Alloy Steel Corporation in Gary, Indiana, which became an operating division of National Tube Company on October 1.

Operation of Tubular Alloy Steel Corporation in Gary was launched early in 1942 to increase production of seamless tubing of alloy steels essential to the war effort. In becoming established as an independent United States Steel Corporation subsidiary, Tubular Alloy operated mechanical facilities and other equipment owned by the Defense Plant Corporation, using the plant site and buildings that had been acquired from National Tube Company. The move does not change the existing arrangement with Defense Plant Corporation, which continues to hold title to the mechanical facilities and other equipment.

Leo J. Mason, vice president of Tubular Alloy Steel Corporation, will be in charge of the Tubular Alloy Steel division and will retain his headquarters in Gary, Indiana.

Giles sales manager

The Atlas Lumnite Cement Company, United States Steel Corporation subsidiary, announces the appointment of Roy T. Giles, service director, as sales manager. Giles joined the North Carolina Highway organization in 1921. He was first materials engineer and later testing engineer during the large road building campaign in that state. After leaving North Carolina Giles joined the Blaw-Knox Company of Pittsburgh, as chief engineer of concrete control and in 1928 joined Atlas Lumnite. He has spent much of his time in the development of refractory concrete, which is used for lining furnaces and in other construction exposed to high temperatures. This use now constitutes a large volume of the present consumption of Lumnite.

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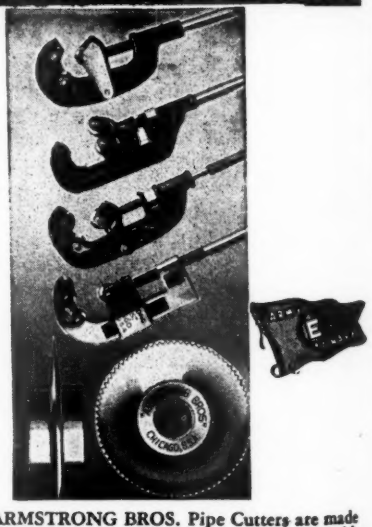

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Zelt to Dallas

Announcement of the transfer of Albert R. Zelt, ranking vice president of Oil Well Supply Company, from Oil City, Pennsylvania, to Dallas, Texas, has been made by Fred F. Murray, president of the company.

Promotions for two other members of the company were announced at the same time. Ralph W. Rager was named comptroller and Byron Hinderer was named assistant comptroller.

Rager replaces Russell M. Braund, whose transfer to American Steel and Wire Company, Cleveland, became effective October 1.

Both Oil Well Supply Company and American Steel and Wire Company are subsidiaries of United States Steel Corporation.

Zelt, 44, formerly was vice president of Oil Well Supply Company in charge of manufacturing, with headquarters in Oil City.

Rager has been with "Oilwell" for 8 years and had been assigned to the company's plant offices at Oil City for 2 years prior to his current promotion.

Byron Hinderer, a native of Oreville, Ohio, has been with "Oilwell" for 13½ years.

"E" award to Peerless

Award of the Army-Navy "E" to employees of the Peerless Pump Division-Food Machinery Corporation was made at a presentation ceremony in Los Angeles, California, recently. The recognition was contained in a letter from Secretary of the Navy James V. Forrestal, who commended the employees on their outstanding production record.

W. K. Cox promoted

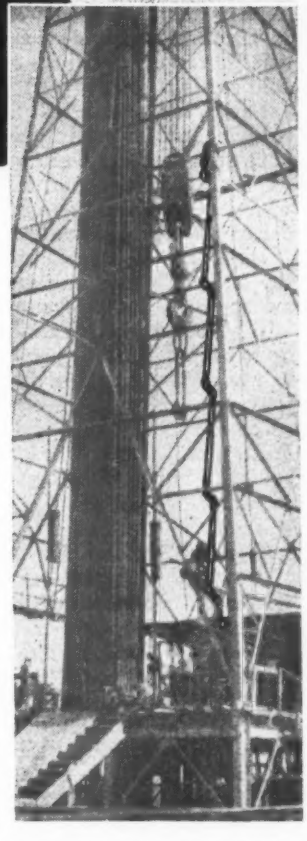
W. K. Cox, assistant sales manager of the eastern division of Caterpillar Tractor Company, Peoria, Illinois, has been promoted to assistant general sales manager. He has been with the company for 16 years, beginning as special representative in logging sales. William S. Ziegler, field representative, succeeds Cox as assistant sales manager, and F. D. Haberkorn has been named assistant sales manager of the eastern district.

Bendix vice president

A. A. Kucher, director of research of Bendix Aviation Corporation and chairman of its long-range planning committee, has been elected a vice president, it was announced by Ernest R. Breech, president.

Kucher is head of the corporation's central research laboratories in Detroit and has charge of investigating and developing new product activities and new business opportunities for Bendix through the long-range planning committee's work, it was stated.

Chiksan hasn't forgotten that the Petroleum Industry was its first customer... and that it has always been a good one. Right now, Uncle Sam gets first call... and no patriotic American would deny his right to preference. As fast... and as soon... as his requirements are met, the Petroleum Industry is assured AAAA1 priority on our list of old customers... and old friends. We look forward with pleasant anticipation to the renewal of old associations and the unlimited privilege of serving a great industry which, too, has done its full share in helping to win the war.



GULF ENGINEERS, INC. – Distributors in Texas, Louisiana, Arkansas and New Mexico.
WELL EQUIPMENT MFG. CO. – Distributors in Oklahoma and Kansas

CHIKSAN TOOL COMPANY
Ball Bearing SWIVEL JOINTS for ALL PURPOSES
BREA, CALIFORNIA

Machinery and Equipment

"De-Ion" Breaker

A new 100-amp. "De-ion" circuit breaker that requires less space and permits lighter structures for distribution panelboards, built-in applications, and bus duct plug-ins is announced by Westinghouse Electric and Manufacturing Company.

All ratings are available in one compact breaker with uniform pole spacings and terminal arrangements, providing complete interchangeability between ratings. The new F frame permits for the first time a 100-amp., 600-volt a-c. or 250-volt d-c. breaker in the same space formerly required by the 50-amp., 600-volt a-c. or 250-volt d-c. rating.

Equipped with thermal and instantaneous magnetic trip elements, the "De-ion" fuseless circuit breaker permits maximum loading of circuits and fast resumption of interrupted service. Contact pressure increases with wear, thereby prolonging the life of contacts and breaker. Silver alloy contacts give increased contact life with lower wattage loss. The special alloys used also prevents "freezing." Both two and three-pole units are available.

Further information concerning the F frame 100-amp. breaker may be obtained from Westinghouse Electric and Manufacturing Company, P.O. Box 868, Pittsburgh 30, Pennsylvania.

All-Service unit

Franks Manufacturing Corporation, Tulsa, Oklahoma, has completed and placed in field service an improved Model 7000 double drum mounted "All-Service" unit designed for extreme adaptability and economy in rig-up and tear town, transportation, and cost of erecting permanent derrick. The unit is completely portable, and carries a telescoping derrick with a maximum height when extended of 96 ft. The derrick telescopes and folds over the cab in such dimensions that it is available for transportation either over traveled highways or over average oil field roads.

Design of the unit had the objective of providing a piece of equipment, completely portable, that would answer any servicing requirement. Manufacturer's literature says the unit will: (1) Drill, with spudder, from grass roots to 3500 ft.; (2) drill, with rotary, from grass roots to 5000 ft. (with independent driven pump); (3) pull rods and tubing to 8500 ft.; (4) drill-in wells to 7500 ft.; (5) spudder clean out and deepen to 7000 ft., and (6) ream, reverse circulate, core, combat paraffin mechanically and do the unexpected job at the producing well.

The power unit is variable upon specifications, and may be up to 875 cu. in., thus providing all the engine power necessary to work normal depths and to 10,000 ft. where rod or tubing jobs are required. Four or five sheaves may be used with drum space for a maximum of 17,531 ft. of ½-in. line on the main drum and 13,415 ft. on the sandreel. The drums may be equipped either with the standard 10-in. brakes or 8-in. when required.

Grooving and cut-off tools

Grooving and cutoff tools of Haynes Stellite cobalt-base alloy are made by Haynes Stellite Company, a unit of Union Carbide and Carbon Corporation. Haynes Stellite grooving tools are finish ground and lapped to specified tolerances. Haynes Stellite cutoff tools are ground to size but not lapped unless specified by purchaser. Both types of tools may be obtained in either 98M2 or Star J-Metal alloy—with Haynes Stellite 98M2 especially recommended for steel.

Grooving tools are supplied in three types—plain, channel, and I-beam—for grooving operations on cast-iron, aluminum, brass, bronze, and steel. The side lands are lapped to give maximum tool life. To resharpen these tools, it is necessary only to grind the cutting end, maintaining the front clearance angle.

Haynes Stellite cutoff tools are made in two styles, identified as Style 1 and Style 2. Both styles are of the double-bevel type, the tapered sides providing side cutting clearances. A 6 deg. angle is incorporated in the top and bottom edge of Style 2 to make it adaptable to certain cutoff tool holders. Both styles are suitable for cutoff operations on tubing, cylinders, or hollow forgings of iron, brass, bronze, aluminum, and some types of steel.

Further information may be obtained from Haynes Stellite Company, Kokomo, Indiana.

Airco heating torch

A new medium-weight heating torch has been announced by the Air Reduction Sales Company. This new torch (Style 9802) is especially designed for concentrated localized heating such as is required for bending, straightening, and shrinking of steel plate as well as for silver-brazing of heavy copper plate in the manufacture of copper pipe. The torch is lighter in weight than heating torches that have been available in the past, yet it has equal gas capacity.

Five new multi-flame acetylene heating tips as well as 2 multi-flame propane heating tips are available for this torch. These 7 tips will meet the requirements of every heavy heating job.

Three mixers are available for the torch, viz., for positive pressure acetylene, low pressure acetylene, and for propane. The available extensions include a 12-in. straight extension and 18-in., 24-in., and 42-in. angular extensions.

For further information, write to the manufacturer, Air Reduction Sales Company, 60 East 42nd Street, New York 17, New York.

Ground clamp for welding

A new ground clamp for welders priced at only $1.50 has been announced by The Lincoln Electric Company, Cleveland, Ohio.

Besides its low cost, the clamp is designed so that each jaw connects independently to the ground cable. Thus, if one jaw is prevented from making a good electrical contact, due to any reason such as heavy scale, paint, etc., the other jaw will carry the current.

The ground clamp has a heavy-duty processed steel frame with durable cooper conductors and contacts. The unit weighs only 1½ lb., has a maximum jaw spread of 2½ in., and a rating of 300 amp.

Briggs Clarifier Company new DR series

The Briggs line of oil clarifiers employing the Briggs patented Fuller's earth block and Briggs specially-developed all-cellulose refill cartridges has been further expanded by the introduction of the new DR Series lubricating oil clarifiers.

The standard DR Series clarifiers have been designed to meet industry's need for an efficient, reliable line of oil filters for by-pass installation. Each unit is equipped with a precision-built relief valve set to maintain the most efficient operating pressure inside the clarifier and to allow circulation through the clarifier when the oil is cold. Flow capacities range from 1 to 20 gal. per min.

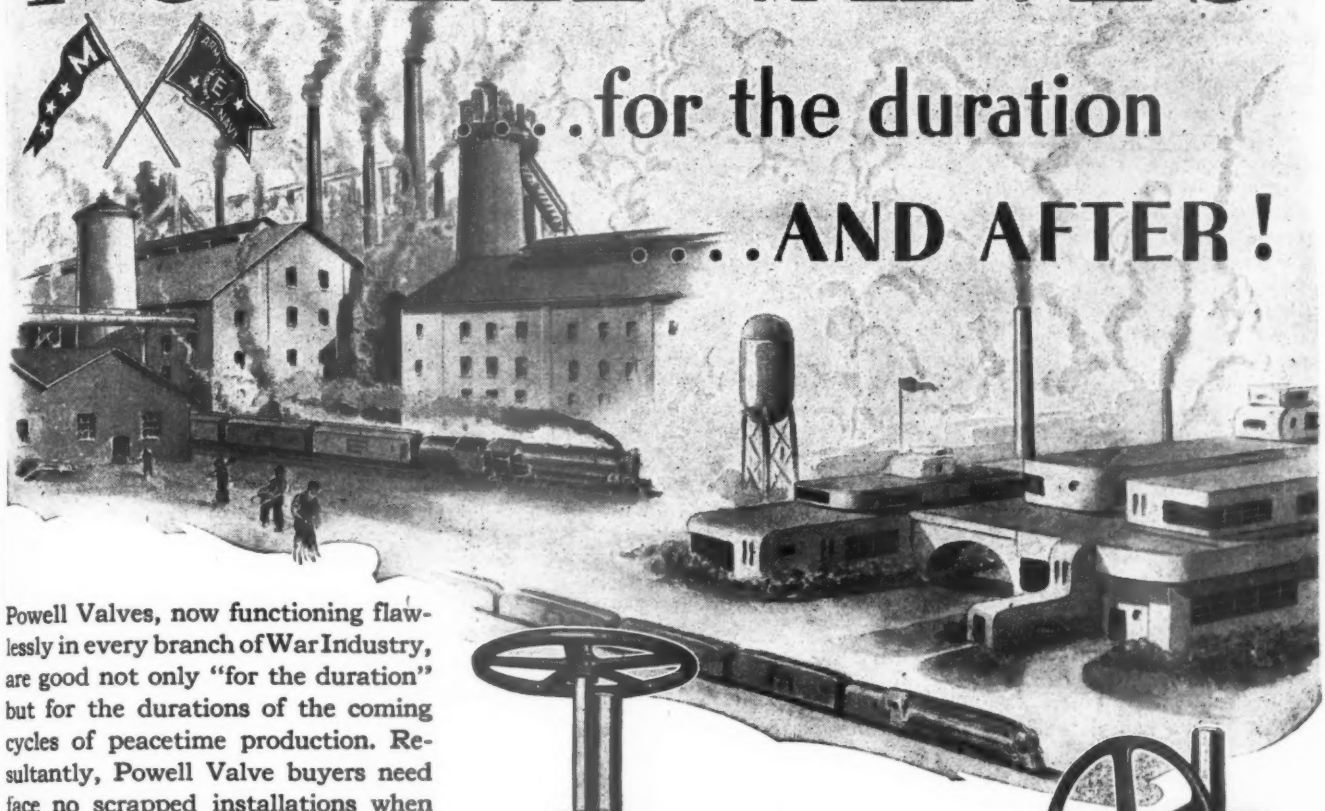
The smaller models in the DR Series are designed for a maximum working pressure of 100 lb. per sq. in. and a hydrostatic test pressure of 150 lb. per sq. in. for use with smaller size internal-combustion engines requiring shunt type installations. For larger size engines where bypass installation is preferred, there are DR models with working pressures of 40 lb. per sq. in. and hydrostatic test pressures of 60 lb. per sq. in.

All standard D-size refill cartridges are interchangeable in the DR Series clarifiers. The center tube of the refill assembly has been enlarged so that the refill will be properly centered on the pressure plates to assure uniform pressure over the entire end of the refill—positive assurance against bypassing.

POWELL VALVES

. . . for the duration

. . . AND AFTER!



Powell Valves, now functioning flawlessly in every branch of War Industry, are good not only "for the duration" but for the durations of the coming cycles of peacetime production. Resultantly, Powell Valve buyers need face no scrapped installations when reconversion comes, whether it come by degrees or all at once.

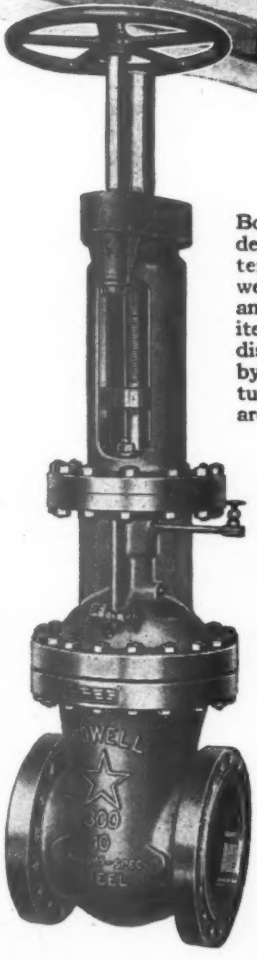
The basic principle of efficient flow control is, at all times, the *right valve,* in the *right spot,* for the *right job.* It is on this principle that the complete POWELL Line of industrial valves of all types and materials has been developed through nearly a century of successful valve manufacture.

The gear operated gate valves shown here were specially designed by Powell Engineering to meet the specific and exacting requirements of high temperature hydrocarbon gas reforming and thermal catalytic cracking in a large western refinery.

The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati 22, Ohio



10", Class 300-pound, Cast Alloy Steel O. S. & Y. Gate Valve. Spur-gear operated.

Both gate valves were specially designed and built for ultra-high temperature service. Double wedge discs, seats, disc guides and stem guides are Stellite faced. Cooling fins for dissipating heat and thereby lowering the temperature in the stuffing box are another feature.

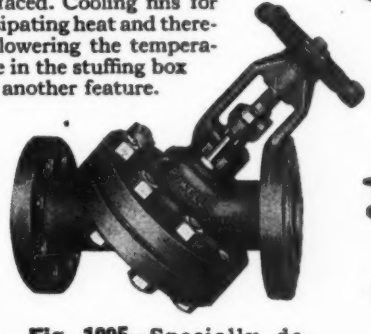
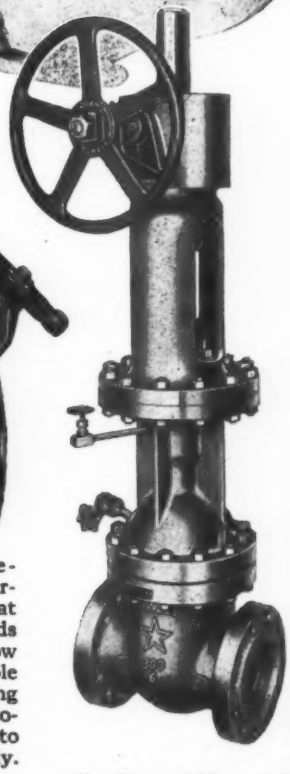


Fig. 1095—Specially designed, extra heavy, Separable Body, Reversible Seat "Y" Valve for 300-pounds W.P. Has straightway flow area through body. Available in special alloys for handling chlorine compounds in isomerization units. Sizes, ½ to 4", incl.; flanged ends only.



6", Class 300-pound, Cast Alloy Steel, O. S. & Y. Gate Valve. Bevel-gear operated.

POWELL VALVES

Corrosion-resisting plastic

Tube Kote Inc., Houston, Texas, has announced the completion of a plant for applying a corrosion-resisting plastic to oil field materials.

The plastic material, which has been subjected to exhaustive laboratory and field tests, can be applied to almost any type of oil field equipment subject to corrosion. This includes tubing, line pipe, casing, valves and fittings, steel tank sections, and sucker rods. The Houston plant is of a special patented design that permits mass application of the plastic. The plastic used is a phenol formaldehyde resin and the material to be given protection against corrosion is dipped into it.

In coating pipe the metal is thoroughly cleaned of grease by submerging in a hot caustic bath. It is then cleaned of loose scale and other foreign particles that might have resisted the caustic bath. The second cleaning, depending upon the type of equipment, may be accomplished either by the grit cleaning process or by sandblasting both the inside and outside of the pipe.

A huge rack holding a number of joints (the quantity depending upon the size) supported by hooks at each end, is hoisted by crane and dipped into a vat of plastic coating material. It is then removed and permitted to drain by inclining the rack. The next operation involves placing the entire rack of pipe into an oven where it is baked at temperatures ranging from 225 to 250°F. After one hour in the oven, the rack is removed, and, when the pipe has cooled it is again dipped. The operation of dipping, draining, and baking is performed four times. Then, on the fifth dip the pipe is placed in the oven and the layers of plastic fused at a temperature of approximately 400°F.

The mechanical rate and viscosity of the plastic determines the thickness of the coating, which under ordinary requirements, is about 0.005 in. The color of the plastic is pale amber to light maroon, and the specific gravity is 0.9. The Gardner-Holdt viscosity at 75°C. is D-G.

The physical characteristics of the plastic seem to meet all known requirements for a corrosion-preventing coating. It has excellent adhesion qualities to metal surfaces, and its extreme toughness gives it the ability to withstand abrasion. The plastic is totally unaffected by most solvents and acids. Although the primary purpose of the plastic application is to prevent corrosion, it also imparts to both the inside and outside surfaces of the pipe an excellent surface slip, or a coefficient of friction as low as that used in flow calculations involving glass surfaces. In addition to this advantage, the slick surface of the plastic prevents the formation of paraffin. Plastic coated material may be used in installations where temperatures are as high as 350°F.

In the laboratory the material successfully withstood the following tests: (1) 50 hr. in an aerated solution of salt; (2) 50 hr. in a device that tumbled, and rotated the speciment at 30 r.p.m. while submerged in a container half filled with a mixture of salt solution and sand; (3) 62 hr. in sulphuric acid solution at 100°F.; (4) 120 hr. alternately refluxing and soaking with the tubular product partly filled with a mixture of benzol, water and leaded gasoline, slowly brought to a boil; (5) 18 hr. in sodium hydroxide, with only slight color change, and (6) samples alternately submerged for periods of 6 months in sour and sweet crudes, with no blister or other apparent effect.

The field tests were equally severe. A string of plastic coated tubing was installed in a flowing well in the Penwell field of West Texas. The purpose of the test was to determine whether the coating was resistant to electrolyte caused by H_2S and Fe. The history of the tubing life in this well showed that previous strings were completely corroded in from 2 to 6 months. After the plastic coated pipe was installed, it was pulled for examination at the end of 3-month intervals during a 15-month period. The tubing was thoroughly inspected each time it was pulled and the coating material showed no change, and there were no signs of corrosion.

As a test against the formation and accumulation of paraffin, a well in California, near the Venture field, was selected. Prior strings of ordinary tubing had to be pulled at intervals of approximately 45 days because of paraffin trouble. The plastic coated tubing has now been in operation 7 months with no indications of paraffin accumulation, according to the manufacturer.

MINNEAPOLIS-MOLINE
TWIN CITY OIL FIELD ENGINES

The POWER BEHIND OIL PRODUCTION

MM oil field engines have all the rugged, efficient, low cost operating and long life service features that are so vital to efficient oil production. Engines that will operate 24 hours per day year in and year out with the very minimum of servicing. Yet when service is necessary they are designed so that all parts are readily accessible. Their compact, heavy duty, extra strength construction assures *Power* that retains its performance standard after long years of gruelling service—*Power* that will work for *you* at low first cost and low upkeep with the added economy of either natural gas or liquid fuels. Built-in force-feed lubrication, valve-in-head design, controlled cooling for gas economy, unit construction, including cylinder blocks removable independently from crankcase and heads, are among the features exclusive with MM. MM oil field Engines are built in 8 models:

165-4A, 3⅝x4, 4 cyl. CUA, 4¼x5, 6 cyl.
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KUA, 4¼x5, 4 cyl. MEU, 8x9, 4 cyl.
LUA, 4⅝x6, 4 cyl. NEU, 8x9, 6 cyl.

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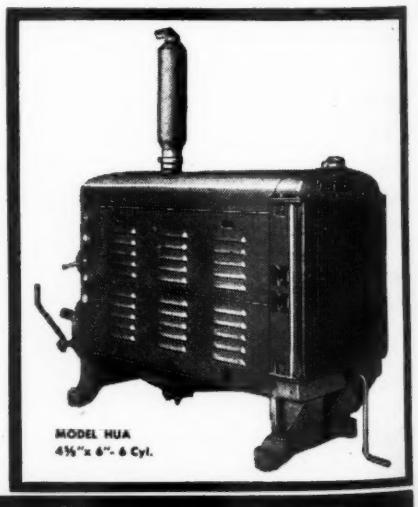
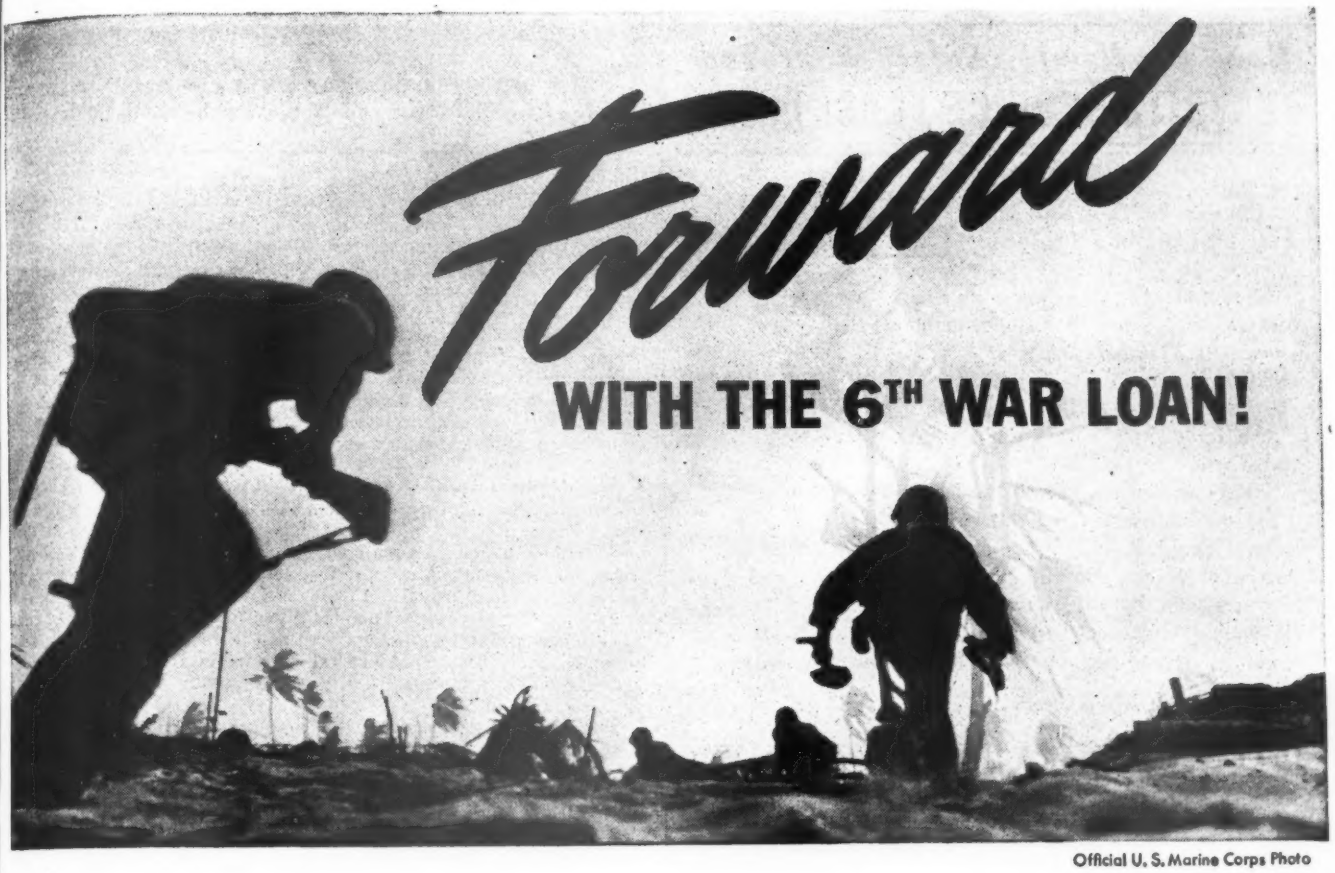


MINNEAPOLIS-MOLINE POWER IMPLEMENT COMPANY
MINNEAPOLIS 1, MINNESOTA, U. S. A.

MINNEAPOLIS MOLINE
TWIN CITY OIL FIELD ENGINES



Official U. S. Marine Corps Photo

Keep Your Plant's Quota "OUT FRONT!"

Victory depends upon materials—as well as men! To keep our American forces "closing in" overseas, you and every other manufacturer here at home must *keep on making* "Out Front" War Bond Quotas!

This means *action now* on *every* point in the fighting 8-Point Plan to step up Payroll Deductions. For instance, have you a 6th War Loan Bond Committee, representing labor, management and other important groups in your company? Selected Team Captains yet—preferably returned veterans? If so, have you instructed them in sales procedure—and given each the Treasury Booklet, *Getting the Order?*

How about War Bond quotas? Each department—and individual—should have one! Assigning responsibilities is vital, too! Have you appointed enough "self-starters" to arrange rallies, competitive progress boards and meeting schedules? Are personal pledge, order or authorization cards printed, and made out in the name of each worker? Planning for resolicitation near the end of the drive? Your State Payroll Chairman is ready now with a detailed Resolicitation Plan. And, have you contracted for space in *all* your regular advertising media to tell the War Bond story?

Your positive *Yes* to *all* points in this forward-to-victory 8-Point Plan assures your plant meeting an "Out Front" Quota in the 6th War Loan—and speeds the day of unconditional surrender!

The Treasury Department acknowledges with appreciation the publication of this message by

THE PETROLEUM ENGINEER

This is an official U. S. Treasury advertisement—prepared under the auspices of Treasury Department and War Advertising Council.

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The New Justrite Service Flashlight is approved for safety by Underwriters' Laboratories, Inc., (Class 1, Group D locations), by U. S. Bureau of Mines, for safe use in Methane Gas and Air Mixtures, and by the Bureau of Marine Inspection and Navigation, for safety in pump rooms of tankers.

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Book Reviews

▼ **Trees and Test Tubes,** *by Charles Morrow Wilson. Henry Holt and Company, 257 Fourth Avenue, New York City. Pages, 350. Price, $3.50.*... In this, Charles Morrow Wilson's twelfth book, he recounts the story of rubber and a rubber-dependent world. The history of rubber is depicted from the bitter jungle epic of the Amazon to the present crisis and a possible solution of the shortage with new synthetics. Included is the story of the discovery of vulcanizing by Charles Goodyear, the history of the rise of the great British and Dutch rubber agriculture of the East, and the panorama of history-making resource and world industry. The author has lived on one of the experimental rubber plantations of Central America, and his book is solidly founded upon both personal knowledge and careful research.

▼ **Standardization of Volumetric Solutions,** *by R. B. Bradstreet. Chemical Publishing Company, Inc., 26 Court Street, Brooklyn 2, New York. Pages, 150. Price, $3.75.*... The author has gathered in this book methods of standardized solutions that have stood the test of laboratory experience, and has described them in a concise manner ready for rapid laboratory use. It is a handy reference book for the man who seeks results. It presupposes a general knowledge and practice of analytical chemistry, gives the good and bad points of the methods, and presents helpful hints, equations, tables of important data, and expressions for calculating normalities.

▼ **The Craftsman Prepares to Teach,** *by David F. Jackey and Melvin L. Barlow. The MacMillan Company, New York City. Pages, 184. Price, $2.*... Written for the assistance of craftsmen and others from industry with little or no previous teaching experience who have been called upon to train workers for many different industrial occupations, this book lists preparation of a course of study with examples to illustrate each group. The authors show how to establish the objectives of a course, how to select the subject matter, divide it into progressive lessons, plan each lesson, organize shop work, and check on the work. The book is simply written, brief, and to the point.

▼ **Chemical Engineering Nomographs,** *by Dale S. Davis. McGraw-Hill Publishing Co., Inc., New York City. Pages, 308.*... Of proved practical value to chemical engineers and to analytical, control, and physical chemists is this book. The author has selected from rapidly growing literature a limited number of alignment and line-coordinate charts and has presented them suitably grouped and indexed and supplemented with coroboratory material and directions for use.

▼ **Review of Petroleum Geology in 1943,** *by F. M. Van Tuyl. Quarterly of the Colorado School of Mines, Golden, Colorado. Pages, 127. Price, $1.*... Covering the important petroleum geological events of the year, the advances in petroleum geology and allied subjects, miscellaneous new and improved techniques, discoveries, production, and reserves, "The Review of Petroleum Geology in 1943" is a complete research publication on the subject. The author was assisted in research and compilation by members of the staffs of departments of geology, geophysics, and petroleum engineering of the Colorado School of Mines.

▼ **Dictionary of Science and Technology,** *by Maxim Newmark. The Philosophical Library, 15 East 40th Street, New York City. Pages, 386. Price, $6.*... Written in English, French, German, and Spanish, Newmark's book, "Dictionary of Science and Technology," is a complete and authoritative study of American and foreign words and terms used in science and technical industries. It includes conversion tables, with an index of foreign terms and abbreviations.

▼ **Standard Method for Testing Petroleum and Its Products,** *Published by The Institute of Petroleum, Manson House, 26, Portland Place, London, W. 1. Pages, 477.*... This is the fifth edition of "Standard Methods for Testing Petroleum and Its Products" and represents a revision of the 1942 edition with additional material. It includes a number of new methods, particularly those relating to derived chemicals and asphaltic bitumen emulsions.

▼ **Plastic Horizons,** *by B. H. Weil and Victor J. Anhorn, Gulf Research and Development Company, Pittsburgh, Pennsylvania. The Jacques Cattell Press, Lancaster, Pennsylvania. Pages, 168. Price, $2.50.*... By reading "Plastic Horizons," a person may supplant interest and curiosity about the important new role of plastics with actual working knowledge concerning its composition and application. This book, written in simple straightforward English, takes up where newspaper articles and institutional advertising leaves off.

Heads Roebling Company

C. R. Tyson

Charles Roebling Tyson has been elected president of the John A. Roebling's Sons Company, manufacturers of wire products, with plants in Trenton and Roebling, New Jersey. Tyson succeeds the late William A. Anderson, who died on September 10.

Announcement of Tyson's election was made at the company's executive offices, following a regular meeting of the board of directors on September 28.

The election of Tyson places in the presidency the grandson of Charles G. Roebling, son of the founder, who became president of the company when he was 28 years old and served in that capacity from 1877 to 1918.

Lt. J. M. Roebling

The election of Lt. Joseph M. Roebling, now serving abroad with the United States Army Air Corps, as chairman of the board of directors of the company, was also announced. Lieutenant Roebling, first vice president since 1936, is a son of the late Ferdinand W. Roebling, Jr., who was the company's president from 1926 to 1936.

Also announced, following the directors' meeting, was the election of Archibald W. Brown as treasurer and H. D. Rathbun as secretary and assistant treasurer.

With Bel-Air Oil Company

Bel-Air Oil Company has increased its personnel and appointed John J. O'Keefe, Jr., assistant general manager. The company now has 15 producing wells with a production of 3000 bbl. per day in the Santa Maria area and has extensive acreage under lease in Santa Barbara and Ventura counties, California, that in Santa Barbara County exceeding 5000 acres. It also has properties in Illinois.

J. J. O'Keefe

O'Keefe was graduated with the degree of mining engineer from State College of Mines and Metallurgy, University of Texas, in 1921. Going immediately to California, he first spent a year with the Southern California Gas Company and Bureau of Power and Light, City of Los Angeles, then entered the geological and petroleum engineering department of Petroleum Midway Company, now California Petroleum Corporation. In 1925 he went with Miley Oil Company as division petroleum engineer but after two years went into business for himself. In 1932 he became assistant to R. H. Garrison, consulting petroleum engineer, and in 1934 he took a position as chief division petroleum engineer with Rio Grande Oil Company and Richfield Oil Corporation. He remained in that position, working in the Coast, Northern and Southern Divisions until his recent appointment as assistant general manager for Bel-Air Oil Company.

Columbia office closed

Consolidation of the Columbia, South Carolina, and Atlanta, Georgia, offices of Pittsburgh Equitable Meter Company-Merco Nordstrom Valve Company was announced on September 1, coincident to the retirement of F. G. Swaffield, district manager of the firm's Columbia office. Announcement of the change was made by A. J. Kerr, general sales manager of the company.

Swaffield's retirement ends his 40-year career with the sales force of Pittsburgh Equitable-Merco Nordstrom.

In assuming control of the Columbia office territory, C. C. Moore, manager of the Atlanta district office, now directs field sales in the entire southeast section of the United States. In this territory are the states of Florida, Georgia, Alabama, Mississippi, Tennessee, North and South Carolina, Virginia, and most of Kentucky.

★ ★ ★ ★ ★ ★ ★

Five Famous Features GUARANTEED of SAND-BANUM

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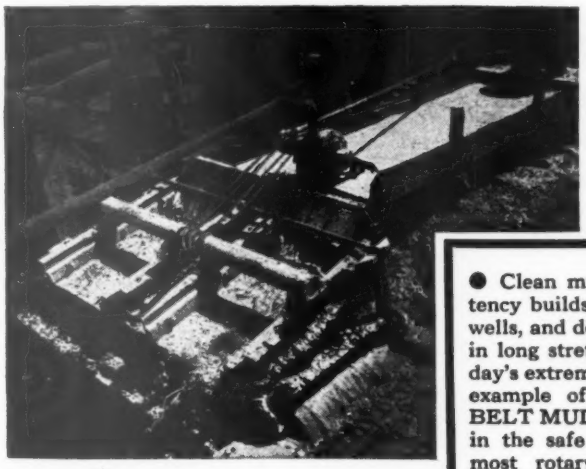

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● Clean mud of the proper consistency builds strong walls for drilling wells, and dependable walls are vital in long stretches of open hole in today's extreme depths. This is another example of the vital part LINK-BELT MUD SCREENS are playing in the safe completion of wells in most rotary fields of the world. LINK-BELT pioneered the use of mud screens for reconditioning rotary drilling mud and is today still the pioneer in improving them.

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LINK-BELT'S Type NRM-124 Dual Unit, pictured above, 24" x 48" screening area each, operates dually from one turbine (or motor), or singly if full capacity is not required. Mounted on a single skid, both screens use the same inlet chute and same collecting tank. Send for Folder 1872-A for full details. 9269

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Latitude and departure tables

The computation of the course of a bore hole from survey records obtained is a simple but also a long and tedious procedure. The mathematics involved are known to any high school student and offer no difficulty in their solution.

An accurate survey of a bore hole involves at least 100 or more records. The calculations to be made, based on these records, require considerable time. There is also the possibility of errors being made in such calculations that may seriously affect the course of the hole to be determined.

To provide a speedy and accurate procedure to determine the course of a bore hole the Sperry-Sun Well Surveying Company has prepared a set of tables that completely eliminate the making of calculations and immediately give the desired results. These tables give the results for angles of inclination in quarter degrees from 0 to 31 and in half degrees from 31 to 45 and in degrees from 45 to 55 for bearing angles in degrees ranging from 0 to 90.

To obtain the result it is only necessary to refer to the table, select the vertical column of angle of inclination and the horizontal column of bearing and obtain the latitude, which is the distance north or south, and the departure, which is the distance east or west from the vertical through the mouth of the well or from the vertical through the preceding point.

The tables give the values of the latitude and departure for each 100 ft. course length. They also give the true vertical depth for each angle of inclination. Geometric calculations are completely eliminated and only in cases where the course length is more or less than 100 ft. it is necessary to multiply proportionately the values obtained from the tables.

The tables also contain a section dealing with the correction of magnetic compass records, a subject that is frequently overlooked when magnetic compasses are used for recording the angle of bearing. This section not only explains the influence of permanent magnetism of the bit and drill pipe upon the compass record obtained, but gives information for the determination of the strength of the magnetic field produced by a drill stem or drill bit and for the determination of the angle of correction.

These tables have been prepared with great effort and expense by Sperry-Sun Well Surveying Company and have been used in their organization for many years. Sperry-Sun has received many requests for these publications and on account of their usefulness to the oil industry Sperry-Sun has agreed to their publication. These tables can now be obtained at the price of $5 per copy from *The Petroleum Engineer*, Box 1589, Dallas, Texas.

J. E. Brown appointed

Announcement of the promotion of J. E. Brown, veteran sales executive of Pittsburgh Equitable Meter Company-Merco Nordstrom Valve Company, to the position of assistant to the general sales manager was made recently by A. J. Kerr, general sales manager of the combined organizations.

J. E. Brown

"Ed," as he is known to his many friends and associates, joined the Pittsburgh Meter Company in 1906. Upon the consolidation of that firm with the Equitable Meter Company in 1926, he was made manager of the Chicago district office, but returned to Pittsburgh the following year as director of sales for the company. In that position he also directed the advertising of the company until a separate department was formed for that purpose. In 1942 the home office sales order department was placed under Ed's jurisdiction, and these added duties aided greatly in preparing him for his new position. He will continue to manage the sales order department in addition to assisting the sales manager.

Born in Ohio, Ed is a graduate of Ohio University at Athens, in commercial training. His 38-year career in active business has been spent entirely with Pittsburgh Equitable Meter Company.

TRADE LITERATURE

Publications listed are sent free upon request.

▼ Additional copies of "Dividends from Your Power Plant," a non-advertising pamphlet published as a service to power plant engineers and executives by Preferred Utilities Manufacturing Corporation, are now ready for distribution. First published last year, the booklet met with such widespread popularity that the company has ordered additional copies, which may be obtained by writing Preferred Utilities Manufacturing Corporation, 1860 Broadway, New York 23, New York.

▼ Chain Belt Company has produced a new folder descriptive of REX Flat Spray Nozzles. The folder, No. 459, besides illustrating and describing the nozzle uses, gives tubular information concerning their discharge in gallons per minute; their dimensions; a list of materials, sizes and prices. They are available on request from Chain Belt Company, Milwaukee, Wisconsin.

▼ Elgin Softener Corporation, Elgin, Illinois, announces an improved water softener in its bulletin 606, which will be sent on request. The bulletin may be had by writing Elgin Softener Corporation, Manufacturers Water Conditioning Equipment, Elgin, Illinois, and requesting bulletin 606.

▼ A bulletin describing its improved Rheotrol, a device to maintain a desired electric power or heat input, or flow of liquids or gases to any process or equipment, has been issued by Wheelco Instruments Company, Chicago 7, Illinois. The bulletin, J303-2, describes the instrument and its operation, and will be sent on request to the company.

▼ Bulletin No. 2539 presenting in concise form the full line of Ransome welding and assembly positioning equipment, has been released by Ransome Machinery Company, a subsidiary of Worthington Pump and Machinery Corporation. Photos, diagrams, specifications and important features of the positioners, as well as load rating tables, are included in the handy 4-page bulletin. Copies may be obtained by addressing the company, Dunellen, New Jersey.

▼ The Fluor Corporation, Ltd., has issued a booklet called "Fluor Torres Enfriadoras Aerator" in Spanish for the benefit and convenience of its South American friends and customers. The 20-page illustrated and colorful booklet may be obtained from The Fluor Corporation, Ltd., 2500 South Atlantic Boulevard, Los Angeles 22, California, or from Agentes Exportadores, Yaras & Cia., 215 West 7th Street, Los Angeles 14, California.

▼ A new pamphlet entitled "Cut Costs With Haynes Stellite Hard-Facing Rods" is available from Haynes Stellite Company, a unit of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York, New York, in single copies for interested individuals, or in quantity for distribution by welding shops to their customers. The pamphlet explains the advantages of protecting wearing parts by hard-facing with Haynes Stellite alloy, lists typical parts that can be hard-faced in various industries, and illustrates some of the pages.

▼ Recent developments of Rockford Drilling Machine Division's Pullmore multiple disk clutches have been set forth in a number of bulletins published by the company and now available to users of Pullmore clutches. The address is The Rockford Drilling Machine Division, Borg-Warner Corporation, Rockford, Illinois.

▼ The Preformed Wire Rope Information Bureau has issued a booklet called "Pertinent to Preformed" in which the characteristics and advantages of preformed wire rope are set forth. The attractive booklet is illustrated with clever drawings and cartoons. It may be had by writing the bureau, 520 North Michigan Avenue, Chicago 11, Illinois.

▼ Western Pipe and Steel Company of California has issued a new catalog covering Trumble oil and gas separation. The well-illustrated 16-page presentation covers oil and gas separation from early days to the present. It shows several types of valves automatic and manual operated as well as replacement parts with charts for valving and capacity requirements. Producers with oil and gas separation problems will welcome this interesting and useful treatise, which may be obtained from the Western Pipe and Steel Company of California, Box 2015-H, Terminal Annex, Los Angeles 54, California.

▼ A 20-page booklet has been issued by Tube Turns, Inc., of Louisville, Kentucky, giving allowable working pressures for welding fittings in 5 classes of piping—power, oil, district heating, gas and air, and refrigeration. Fourteen convenient tables list allowable pressures at the indicated temperatures for any size and weight Tube-Turn fitting. Copies may be had from the company, Tube-Turns, Inc., Louisville, Kentucky.

▼ A 16-page bulletin presenting helpful facts and detailed information on the development and prevention of corrosion in gas holders has been prepared by The Stacey Brothers Gas Construction Company. All requests for copies will be filled if addressed to Stacey Brothers Gas Construction Company, Cincinnati, Ohio.

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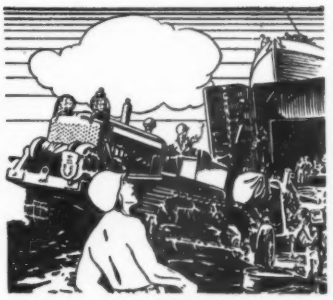

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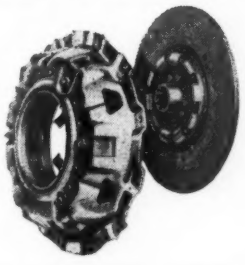

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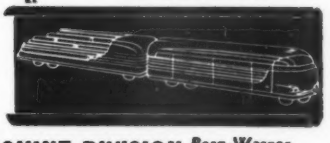

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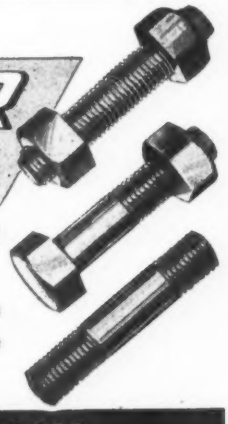

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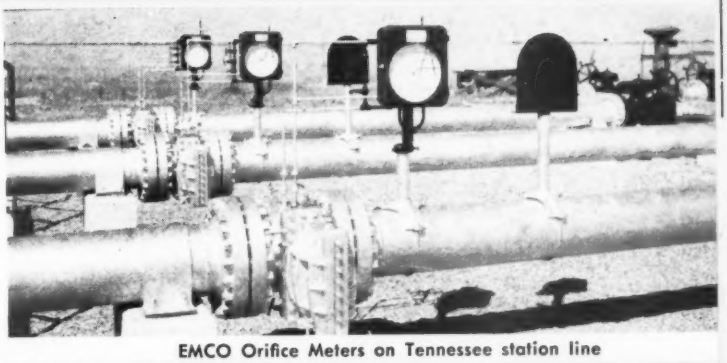
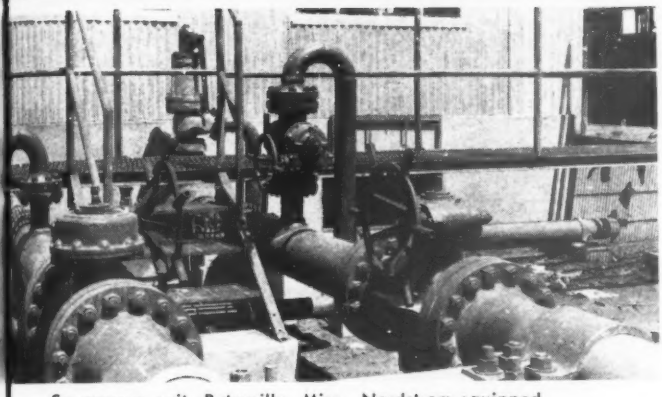
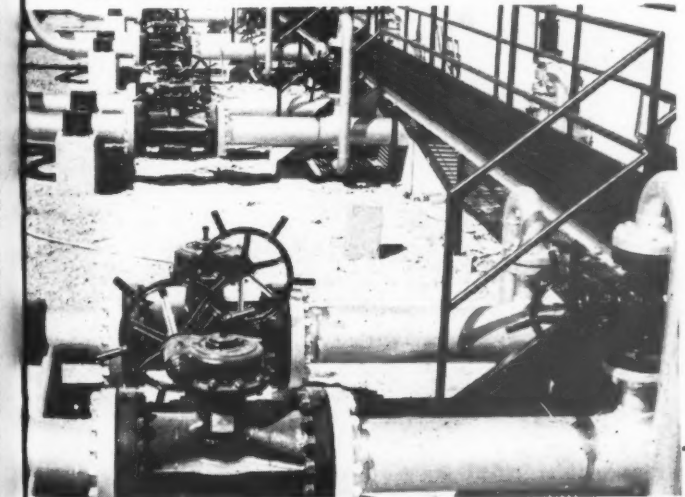


EMCO Orifice Meters on Tennessee station line



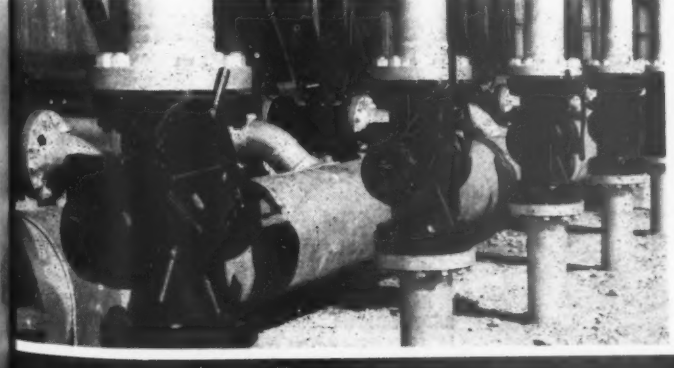
Compressor unit, Batesville, Miss., Nordstrom-equipped

Relief gate risers equipped with Nordstrom Valves



Compressor lines at Batesville, with Nordstrom Gear-Operated Valves

East Bernard, Texas, station showing EMCO No. 2½ Gas Meter



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